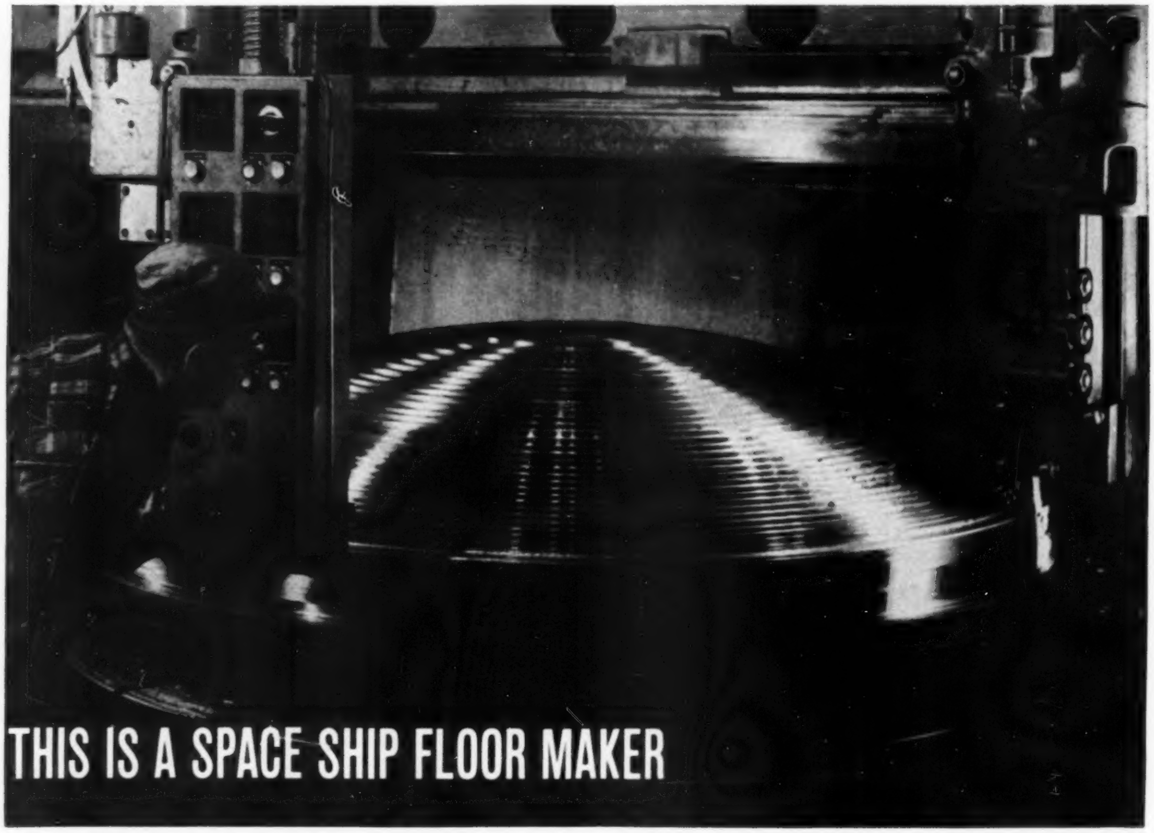
the Cornell

engineer

DEC., 1960
VOL. 26, NO. 3
25 CENTS

Sometime within the next several years, the first American will soar into orbit around the earth. He will be sealed in a small, cone-shaped space capsule mounted atop an Atlas missile. The missile will climb 100 miles in less than six minutes, where the capsule will disengage and go into orbit. The man will be alone in space.



The vehicle for this historic voyage is already in production under the auspices of the National Aeronautics and Space Administration's "Project Mercury." One of the methods of heat protection is a beryllium heat sink, forged on two giant steel dies. Both dies are USS Quality Steel Forgings. The top die (shown being rough-machined on one of our vertical boring mills) will be convex, 20 inches thick and will weigh 26,520 pounds. The bottom die, concave and 18 inches thick, weighs 27,700 pounds. Both are 92 inches in diameter.

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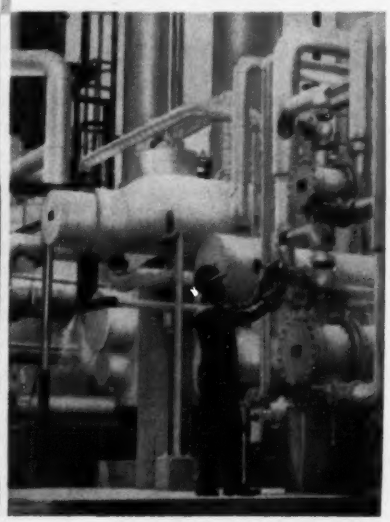

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THE CORNELL

engineer

DECEMBER 1960 VOLUME 26 No. 3

COVER shows an architect's sketch of Cornell's nuclear reactor facility, now nearing completion.

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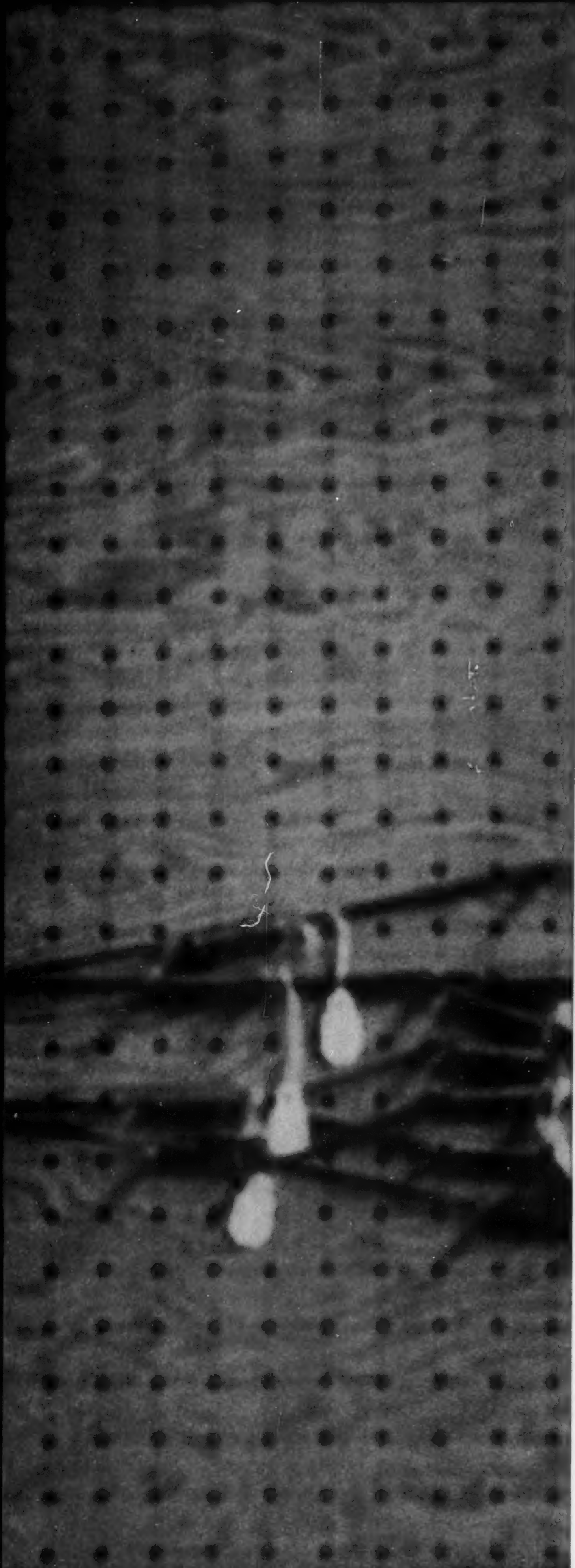
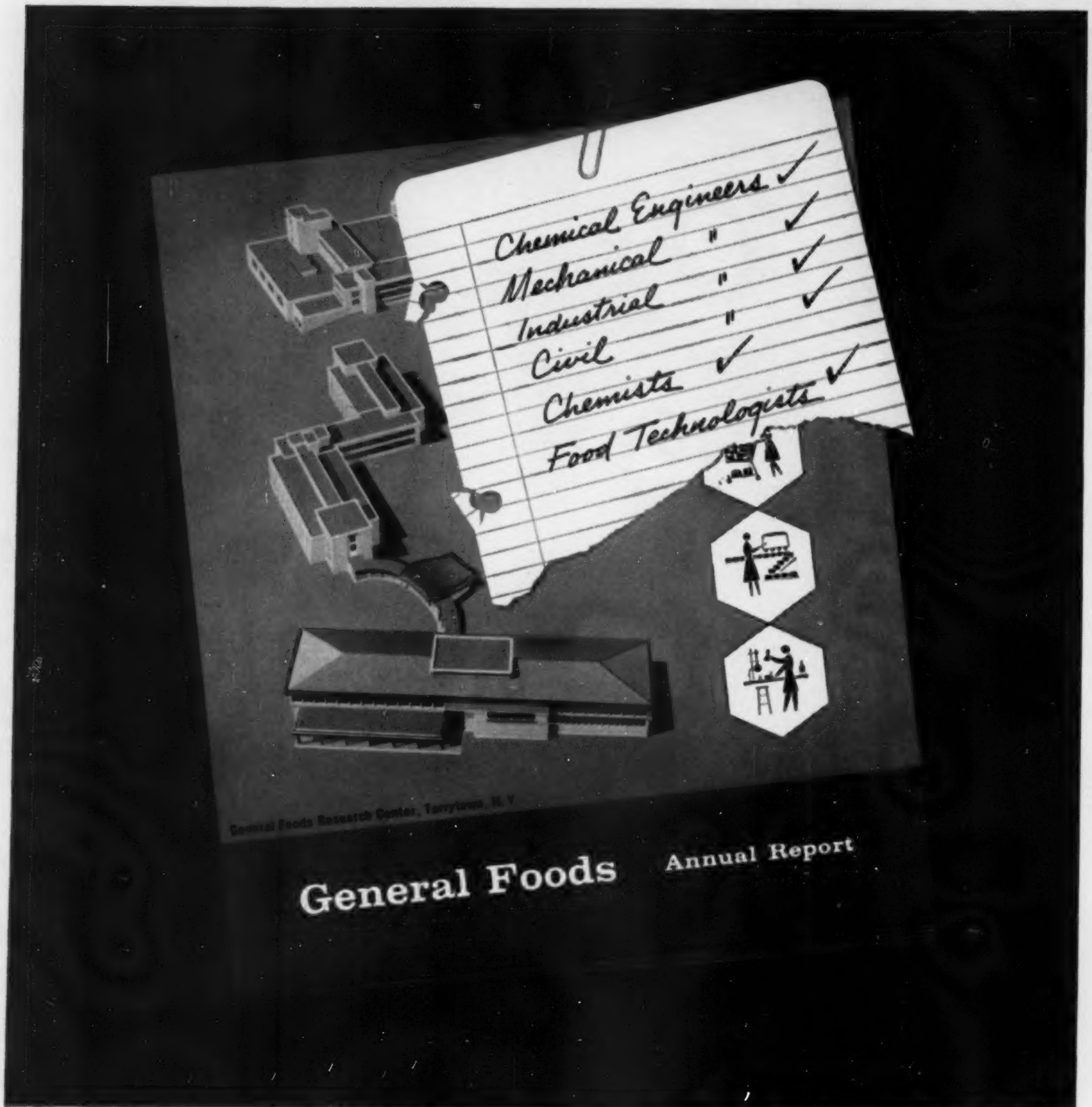
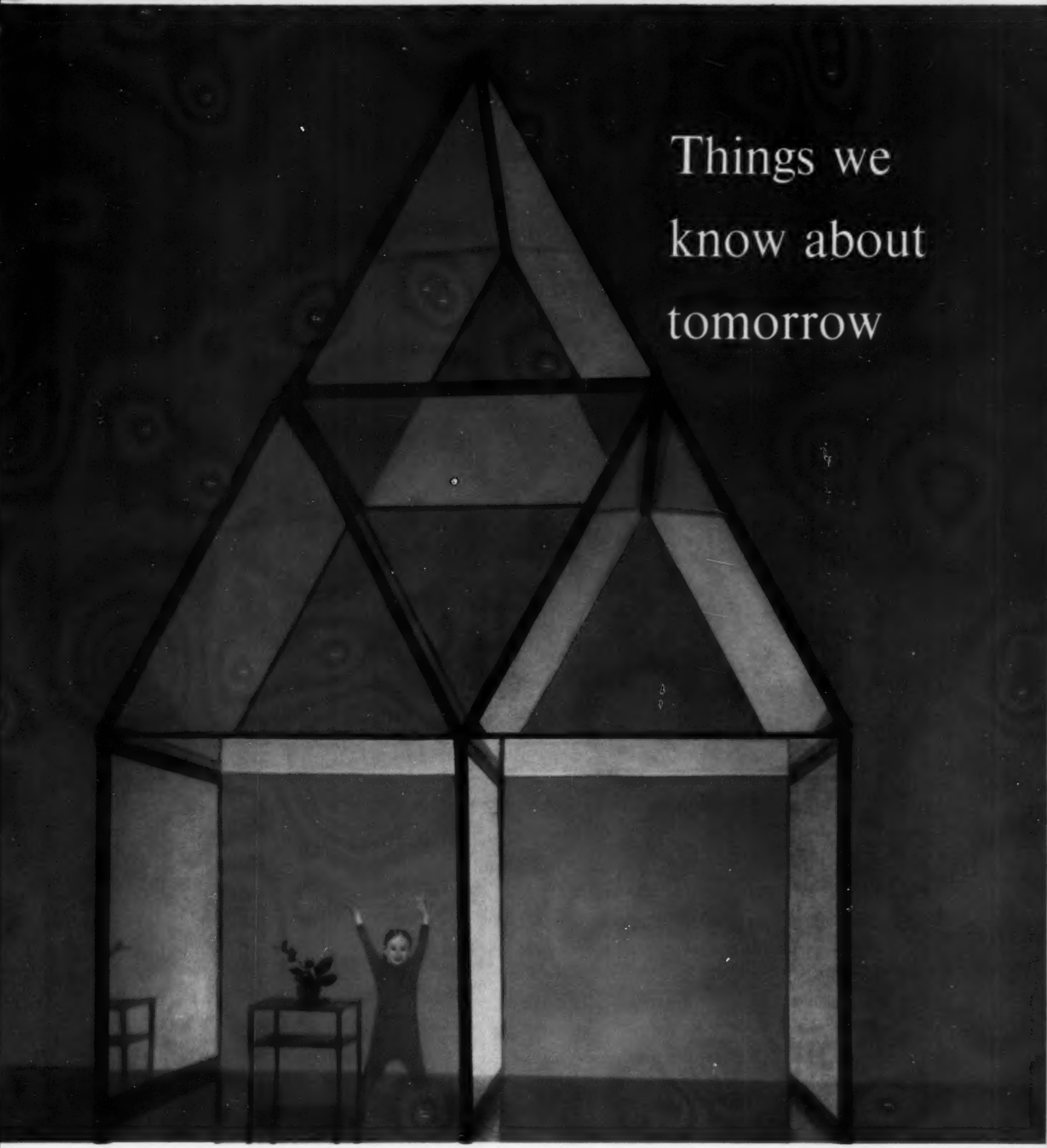




Facsimile of 1958 Annual Report



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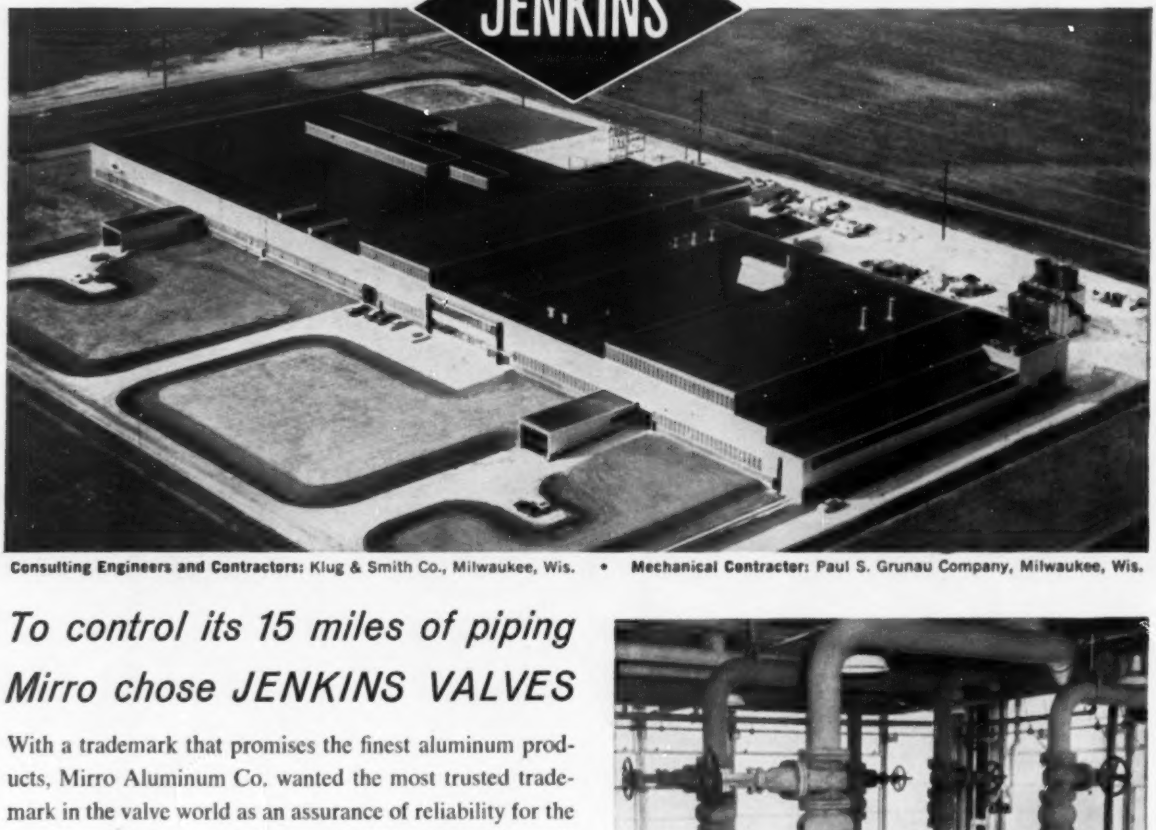

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LOOK FOR THE JENKINS DIAMOND

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FLUORESCENT DYE

NEW WHITENER FOR THE PAPER INDUSTRY

by John A. Ruether, ChemE '64

Whiteness, the symbol of quality in paper, has a great appeal to the human eye. For this reason, paper makers have constantly sought methods for increasing the whiteness of their product. In general, paper will appear whiter if it reflects more light, or if the light it reflects is more neutral, that is, achromatic. Until recently, paper makers have used three processes to create this whiteness. They have treated the pulp with chemical bleach, added white pigments to the paper, and added blue dye to the paper. However, within the past decade, the paper industry has found a new device namely, fluorescent dyes. The use of fluorescent dyes is by far the most interesting of whitening processes.

In the making of high grade paper, one whitening process is never used exclusively. A combination of the separate processes is employed to arrive at paper with the desired characteristics. It is therefore necessary to have an idea how each of these whitening processes works.

Chemical Bleaching

Chemical bleaching of the pulp is employed to remove most of the color from paper. Unbleached pulp has a brown hue. Bleaching destroys this natural color and leaves the pulp semi-white. Addition of bleach to natural pulp causes very noticeable whitening at first. However, as more and more bleach is added, the color of the pulp approaches that of "natural paper white". This color, a yellow white, represents the limit of whiteness that can be achieved by bleaching the pulp. However, the pulp is rarely bleached to this limit, since excessive bleach damages the cellulose fibers and impairs the physical properties of the paper produced. Bleaching can only be used to the point where the best bleaching effect is obtained with the least damage to the pulp fiber. Chemical bleaching by itself, then, cannot make pulp white enough to produce high quality paper; one or more of the other whitening techniques must be employed.

Addition of White Pigments

The first such technique is the addition of white pigments to the pulp. This process, calling loading, has the effect of diluting the yellow color present in the paper. The theoretical limit of whiteness which loading can attain is, of course, the color of the pigment itself. Therefore, dark stock of low brightness shows the greatest whitening effect due to pigments. However, there is a limit to the amount of yellow color that loading can counteract, since pigments cannot be added to the stock in indiscriminate amounts. Because of this the pigment must be much whiter than the stock in order to produce as much whitening action

→

From wet stock to paper — although it is far from finished paper. This transformation happens here before your eyes as the pulpy mixture is carried down the machine on a moving wire bed. Suction and heat remove about 30% of the original water content, giving the paper sufficient body for further processing.

Rising Paper Co.

In the air dryer, the paper receives a uniform finish. This close-up photo of the paper passing through the dryer appears to be an abstract design.

Rising Paper Co.

←

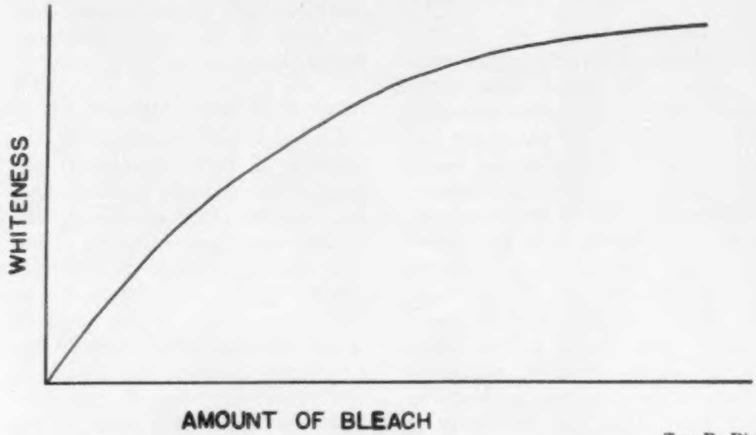
as possible. Unfortunately, few pigments satisfy this condition of super-whiteness and these few are relatively expensive, so that financial considerations impose a limit on the brightening of paper in this manner. (1) In addition to their whitening effect, loading agents are also valuable because they improve the opacity and printing characteristics of paper. Some common loading agents are titanium dioxide, china clay, and recently, silicates.

Addition of Blue Dye

A third way of increasing whiteness is addition of a blue dye. Actually the dye need not be blue, but blue is most generally used because it is roughly complementary to the yellow-brown color of the pulp. The theory behind the use of dyes is that the color of the dye and the color of the untreated pulp will neutralize each other and result in a white color. Usually, however, a little more blue dye is added than is necessary to compensate for the color of the pulp, since most people prefer a white with a slight blue tint to a pure white.

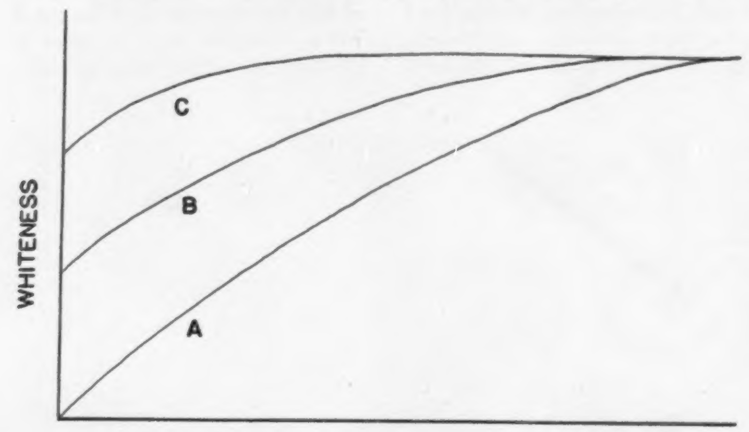
The addition of blue dye unavoidably causes a decrease in light reflection. For a limited amount of dye this loss of brightness is small though, and the advantage of obtaining a neutral color outweighs it.

Low brightness stock is difficult to improve with dyes. So much dye is needed to overcome the brown color in the pulp that the overall brightness decreases greatly. This loss of brightness is in many ways as detrimental as the original brown color, and the net effect is a dull gray color. On the other hand, blue dye can cause only slight whitening improvement on stocks of initially high brightness. Even at low concentrations of dye it is possible to overshoot the white and end with a blue pulp duller than the original stock. For these reasons blue dyes are most effective on neither very bright nor very dull stocks, but on those of medium brightness.



Tom De Dio

Fig. 1—This curve shows schematically how the first quantities of bleach added are able to improve the whiteness of a sheet of paper but that after a large amount of bleach has been added, and there is no longer any natural brown color matter remaining to be destroyed, no further improvement in whiteness can result.



Tom De Dio

Fig. 2—These curves show the effect of increasing concentrations of pigment on stock of various degrees of brightness. Curve "A" shows the large increase in whiteness which can be imparted to a stock of low brightness. The whiteness of the pigment itself is the theoretical ultimate. Curve "B" shows how a stock of medium brightness can be improved. Curve "C" shows that very little additional whiteness can be imparted to a sheet which is very white to begin with by pigmentation because the whiteness of the unpigmented sheet is almost as great as the whiteness of the pigment. In practice the three curves would not meet because of limitations of pigment which can be added.

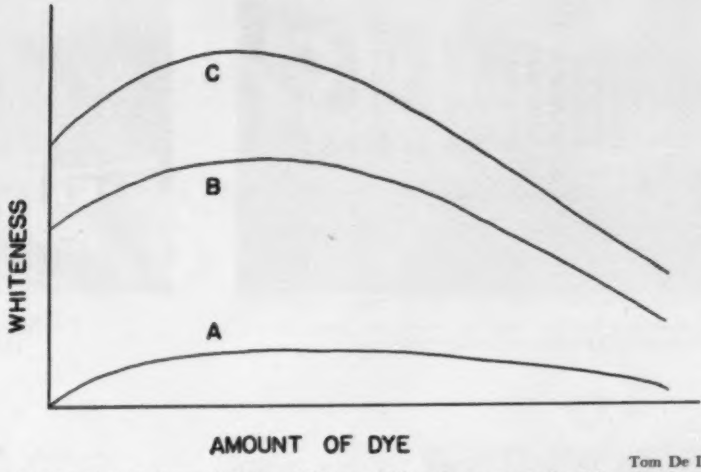
Addition of Fluorescent Dye

The latest method of whitening paper is the use of colorless fluorescent dyes. Their whitening action is due to their ability to absorb ultraviolet light and re-emit it as visible blue light. This ability to give off more visible light than they receive gives fluorescent dyes, or optical dyes as they are sometimes called, a fundamental advantage over other blue dyestuffs. Both conventional and optical dyes increase whiteness by neutralizing the natural yellow color of the pulp. Conventional blue dyes do it by absorbing the yellow color and lowering the overall reflection of light. Fluorescent dyes accomplish the same effect by emitting blue light, actually increasing the reflecting quality of the pulp while neutralizing the yellow color. Because of this unique capability of transforming invisible rays into visible light, optical dyes can make papers far brighter than is possible with the other whitening methods.

One must not conclude, however, that optical dyes are one step, all purpose whiteners. The whitening action of optical dyes is quite different from that of chemical bleaches, and they will never replace bleaching. Bleaches achieve whiteness by destroying and washing out the substances that cause the brown color, whereas optical dyes depend on over-

powering the brown color of the pulp with their blue fluorescent light. For low brightness stocks, where chemical bleaching works most effectively, optical agents are of little use for two reasons. First, the brown matter in the pulp absorbs most of the ultraviolet rays upon which the fluorescent dye depends for its whitening action. Second, the color of the pulp is too dark to be overcome by the limited amount of blue light generated. The dyes work best on well bleached stocks of high brightness, since in this case they can utilize nearly all the incident ultraviolet light in their fluorescing action. One might say that fluorescent dyes begin where the older whitening methods leave off.

Optical dyes work well in combination with loading agents. As a general rule, the whiter the pulp has been made through the use of loading agents, the better is the brightening effect with the dyes. Silicates work especially well because they fluoresce slightly themselves, augmenting the fluorescence of the dye. Titanium dioxide, on the other hand, hinders optical dyes because it absorbs ultraviolet rays and gives a brownish fluorescence.



Tom De Dio

Fig. 3—Curve "A" shows that the addition of blue dye to a stock of low brightness has very little effect on its whiteness. Curve "B" shows schematically that the whiteness of a stock of medium brightness is increased to an optimum concentration of blue dye and then is degraded rapidly as additional dye is added. Curve "C" shows that a stock which is very white to begin with can be made only slightly whiter by the addition of blue dye and the degradation of whiteness begins with low concentration of blue dye.

Beater Application

Fluorescent dye can be applied to paper in two ways. It can be used either to brighten the stock before it is made into paper or to brighten the surface of the paper itself. Brightening the stock is the better method, and is done by a process called beater dyeing.

In this method, the dye is added to the stock while it is being processed in a machine called the beater. The beater mixes the stock and drives moisture into the individual fibers. The dye is added as an aqueous solution during the beater cycle. Since fluorescent dye is sold as a powder or concentrated liquid, the dye solution must be mixed to the desired strength before it is added to the beater. The dye is added during this phase of manufacture to insure thorough mixing with the stock. Improper mixing would cause the paper to become mottled, some parts containing the dye and others not. This mottled condition might not be evident in sunlight but would quickly show up in a test under an ultraviolet lamp.

When fluorescent dyes are used, the stock must be kept basic during the beating cycle. As a solution of fluorescent dye is made increasingly acidic, it becomes turbid at a certain characteristic pH value. The turbidity is due to the formation of color acid which is insoluble in water. The fibers cannot absorb the dye in this state, so the whitening action in the resulting paper is reduced. Once the fibers absorb the dye, however, the solution can be made more acidic without impairing the fluorescence of the paper.

Surface Brightening

To brighten the surface of the paper, a thin film of fluorescent dye is applied to the sheets when they emerge from the long line of rolls and presses used in manufacture. The paper is run through a bath containing a solution of glue or starch and the fluorescent dye. This method of application is not as popular as beater dyeing because the beater dyed paper shows a greater fluorescence.

A disadvantage of these optical dyes is that papers treated with them are not much brighter than untreated papers when viewed under artificial light. The ultraviolet content of artificial light is not great enough to cause the eye-catching brightness which fluorescent dyed papers have in natural sunlight. Fluorescent dyed papers may also lose their brightness when exposed at length to bright sunlight. The dye "wears out" and ceases to fluoresce.

This latter shortcoming is being remedied as the fruits of research produce better dyes. The price of optical dyes has come steadily downward since their initial use by the paper industry. They are now used in a great variety of paper products—writing paper, cigarette paper, art paper, photographic paper, and others. Already very popular, fluorescent dyes should find increasing use by the paper industry.

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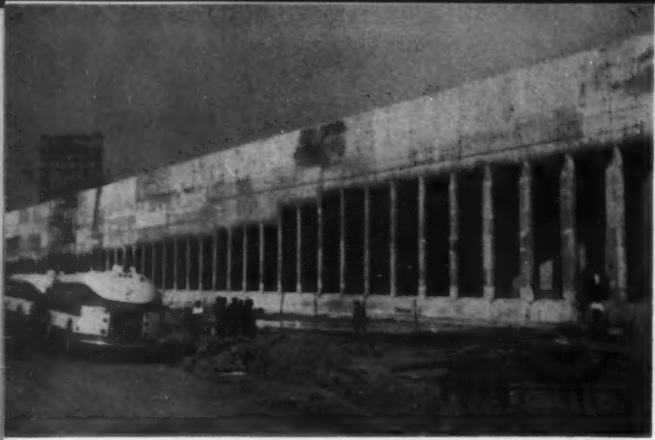
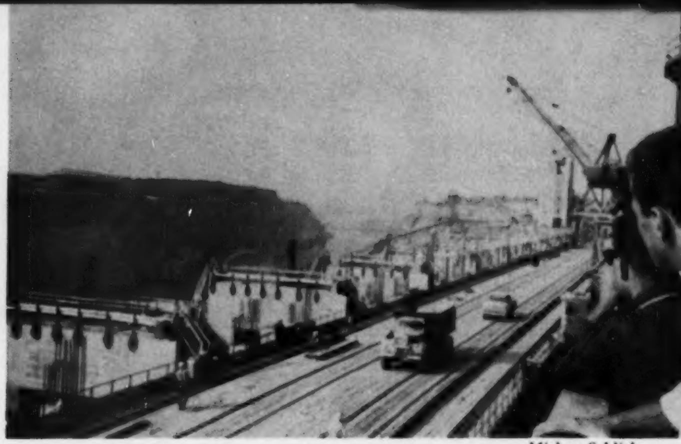
Footnotes

(1) "Phorwite Bup in the Paper Industry," Verona Dyestuffs, Union, New Jersey.



Mickey Schlick
Water intake structures for the conduits, which are kept dry for construction by a half-mile long cofferdam.



Mickey Schlick
The Niagara River as seen from above the Niagara generating plant; Canadian power plant in left background.

THE NIAGARA

A PICTORIAL

Mickey Schlick
Intake to Niagara generating plant, and west end of forebay.

In June 1956, a power station near Niagara Falls was partially destroyed by a rockslide. A resultant power shortage caused the Power Authority of New York State to begin construction of the Niagara Power Project. Construction began in February of 1958, and the project should be completed by February of 1961. Niagara is the largest hydro-electric development in the Western World, and will cost about $720,000,000. The total installed power at Niagara's two generating plants will be 2,190,000 kilowatts.

The freshmen civil engineering class of Cornell was given the opportunity to take a trip to the Niagara Power Project this fall. Professor W. L. Hewitt, C. E. frosh advisor, was in charge of the fifteen hour trip. Two buses were taken to the Niagara Power Project, where the class visited first the intake structures (see diagram), then the reservoir pumping-generating plant, and finally the Niagara generating plant.

Although the intakes for the conduits are located 2½ miles above the falls, the two power plants are several miles downstream from the falls. The purpose of constructing the plants downstream is to produce maximum power: the river drops 160 feet at the falls, but it also drops 50 feet above the falls and over 100 feet below the falls. Thus, the drop between the intakes and the power plants is over 300 feet. The intakes feed two conduits, each of which is 46 feet wide and 66 feet high. The conduits carry water to the forebay connecting the two power plants.

The Treaty of 1950 between

The Canadian Falls.
Mickey Schlick

Lower Niagara River, and Niagara generating plant.
Mickey Schlick

Mickey Schlick

Map of Niagara Power Project area.

Mickey Schlick

Gantry cranes atop the reservoir pump-generating plant.

POWER PROJECT

FEATURE

Canada and the United States limits the amount of water that may be taken out of the upper Niagara River during the daytime. Thus, a reservoir is needed to increase the flow of water into the Niagara generating plant at this time. At night, the pumping-generating plant pumps excess water into the reservoir, which has a capacity of about 20 billion gallons. During the day this water flows out of the reservoir and the electric water pumps are reversed to become turbine-generators. Thus, the electrical output of the two plants does not diminish in the daytime although much less water is taken from the falls then than at night.

The Niagara generating plant contains thirteen 150,000 kilowatt turbine-generators, which are the largest of their kind ever constructed. Each generator is fed by a penstock 24 feet in diameter. The plant is 1530 feet long and 389 feet high. The total cost of the Niagara generating plant should be about $177,170,000.

The freshmen civil engineering class was impressed by the huge amounts of material that had to be transported from one place to another, and by the great size and exactness in construction of every structure in the project. Professor Hewitt and the class considered the trip very helpful in developing a greater appreciation and understanding of civil engineering.

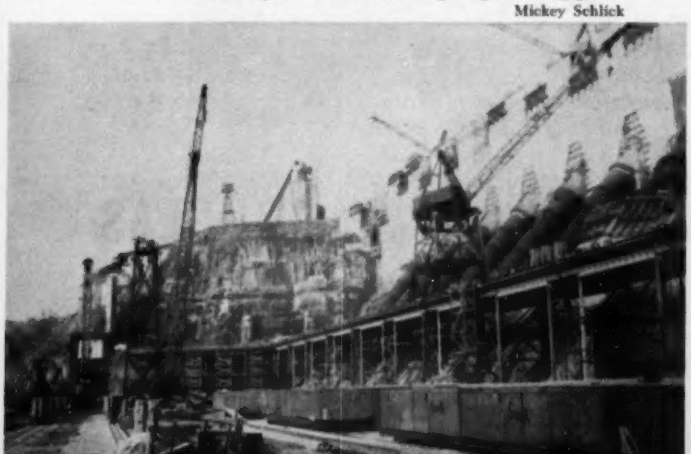
The facts and details included in this paper have been obtained from a pamphlet entitled "Niagara Power Project—1960" put out by the Power Authority—State of New York.

Mickey Schlick

Intakes to reservoir pump-generating plant, and east end of forebay.

Some of the thirteen penstocks of the Niagara generating plant.

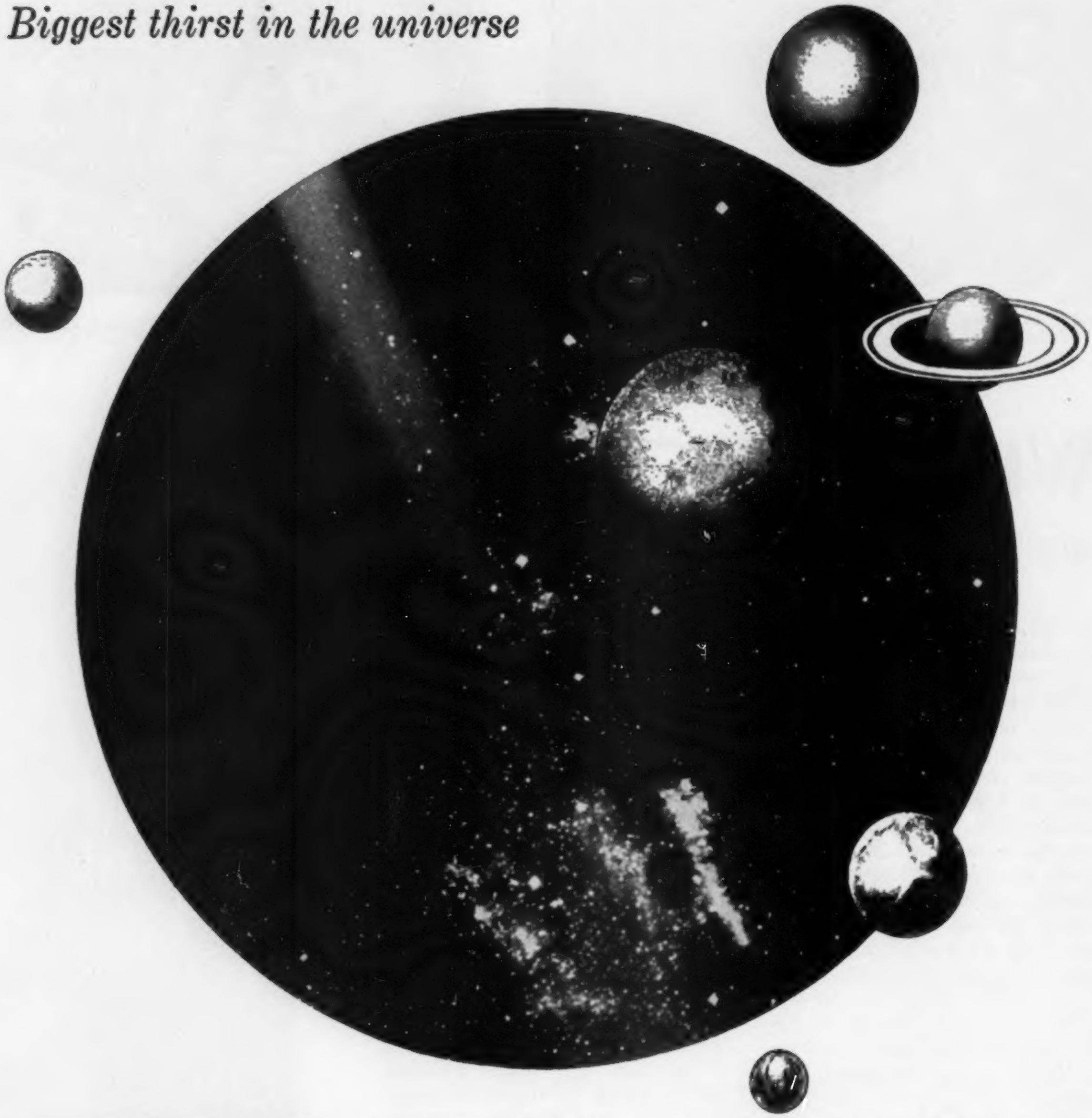
Mickey Schlick



Inside view of one of the two intake structures.

Mickey Schlick

Biggest thirst in the universe



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Dr. Henry Ponsford, Chief, Structures Section, discusses valve and fuel flow requirements for space vehicles with Donald W. Douglas, Jr., President of DOUGLAS

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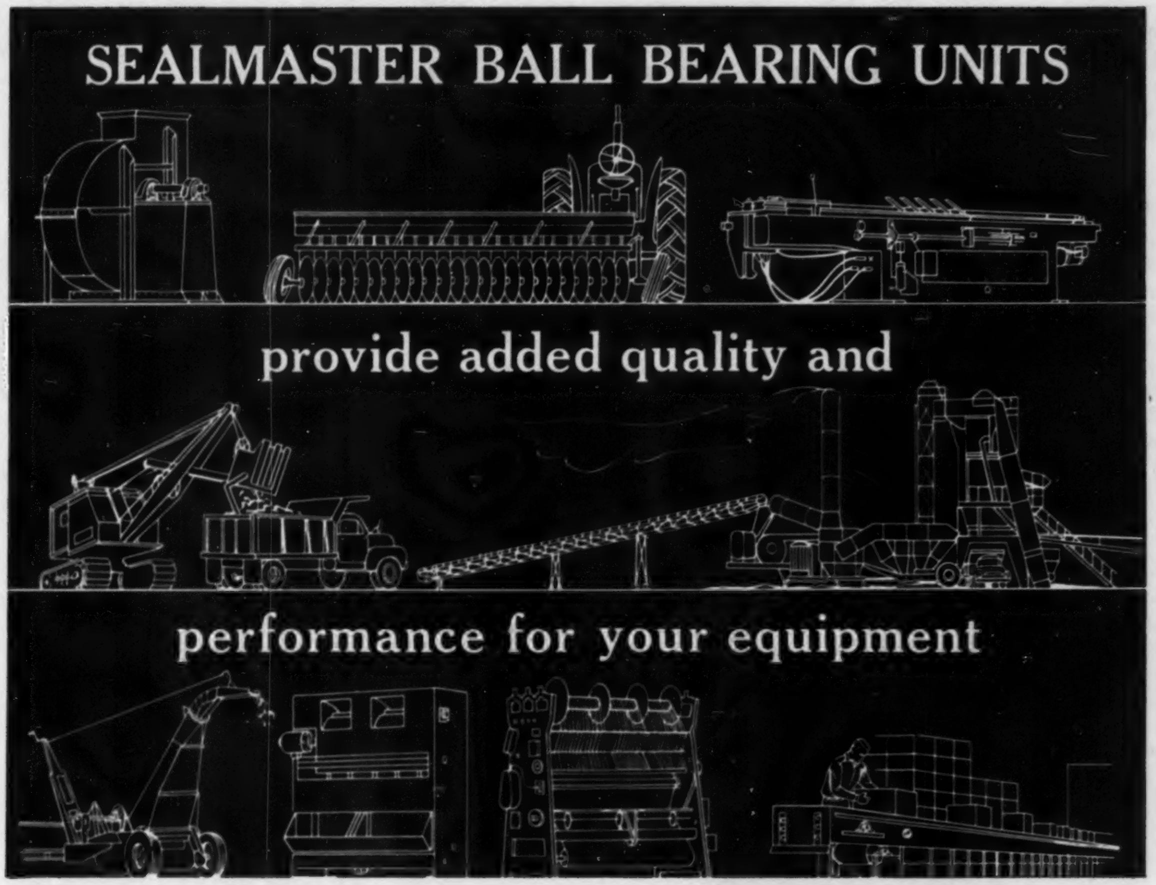

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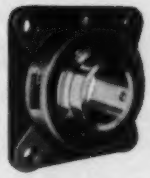

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ITHACA'S TV CABLE

UNIQUE FACILITIES PROVIDE VERSATILE PROGRAMMING

by Gerald V. Lucha, EE '61

Few people who have ever tried to listen to the radio in Ithaca at night will dispute the fact that Ithaca is a fringe reception area. Ithaca is about fifty miles from any large city, and is surrounded by hills on all sides. In spite of these obstacles, the people of Ithaca enjoy better television reception than those living in all but the largest of cities. For example; Buffalo, New York, a city with a population of a million, has only three TV stations. Philadelphia, Pa., the fourth largest city in the U.S., can receive only four channels. In Ithaca, it is possible to receive five television stations. Citizens in Ithaca enjoy a more varied program than those living in cities a hundred times as large.

This excellent programming is made possible by Ithaca's television cable service, owned and operated by the Television Shop of downtown Ithaca.

Hilltop Reception Sites

An important feature of any cabled television system is a well located and sensitive antenna; the

←

The Connecticut Hill receiving location.
Jerry Lucha

cable service provides the benefits of an ideal hilltop antenna location to every one of its subscribers. Television signals from nine different stations are received at two locations in the hills outside of town, amplified and retransmitted electronically, and cabled to the homes of the viewers. As a starting point in a study of the cable service, the reception points will now be described. There are two such points, one on Connecticut Hill, the highest point in Tompkins County, and another on Snyder Hill near the Cornell University dog laboratory.

The Connecticut Hill site (shown in the photo) consists of a tower supporting the following antennas: one UHF Yagi, two VHF Yagis, one UHF bedspread, one parabolic screen and one microwave dish. With these antennas, channels five, ten, sixteen, twenty-two, twenty-eight, and forty can be received. At the base of the tower is a small concrete building containing electronic gear. Here the weak signals are amplified, and then transmitted, via microwave link, to the central distribution point, at Schuyler Place in Ithaca.

The Snyder Hill site is similar to the Connecticut Hill site except for the method of relaying the amplified signals to the central distribution point: there is a cable link between the Snyder Hill antennas and the main distribution point, instead of a microwave link. The use of a cable is feasible because Snyder Hill is much closer to the main distribution point than is Connecticut Hill. Snyder Hill has facilities for receiving channels three, eight, and twelve.

The two reception sites together provide for the reception of nine different channels. These channels originate from Binghamton, Syracuse, Rochester, Scranton, and Wilkes-barre. Since many TV programs are network shows, these nine channels contain a certain amount of duplication. For this reason, only five of the channels are selected at any one time for transmission over the cable.

Central Distribution Point

The main distribution point for the cable service is located in the top floor of an Ithaca College sorority house on Schuyler Place. Here, the signals are received from Connecticut and Snyder Hills.

It will be noted that the reception facilities previously discussed provide for reception of several UHF channels. Between the time they are received and the time they are transmitted over the cable, the UHF channels are retransmitted on the VHF channels to avoid the need for a UHF converter on each home TV set. In addition, trouble is encountered with adjacent channel interference when channels in the high VHF band (channels seven to thirteen) are transmitted simultaneously over the cable. Some channels in this band are converted to other channels to eliminate this problem. Examples of these channel changes are the transmission of channel twenty-two from Scranton, Pa. as channel five on the Ithaca cable, and, transmission of channel twelve from Binghamton, N.Y. as channel two on the cable. It should be noted that the cable must tolerate a set of conditions that no TV set is designed to meet. The FCC never assigns adjacent channels to stations which are geographically close. Since the cable service receives programs from Rochester, Syracuse, and other cities, special steps must be taken so that several equally strong stations will not be transmitted on adjacent frequencies on the cable. The average TV set is not able to clearly distinguish separate stations under such conditions, and will tend to overload and cause intermodulation on some channels.

Cabling The Signal To The Customer

The five channels which are selected to be sent over the cable after conversion to appropriate channels, are then sent out over a series of main coaxial cables. These main cables separate into other branch cables and finally, to individual cables leading to the subscribers' homes. There are about 100 miles of cable in the Ithaca network.

There are two main problems connected with the cabling itself. Since there are considerable signal losses in the transmission of the VHF range over coaxial cable, amplifiers must be provided along the lines to boost the weakened signals. These amplifiers are spaced every 1000 to 2000 feet along main cables. Each amplifier consists of five individual VHF amplifiers, one for each channel sent over the cable. There are about 100 of these amplifier units on poles throughout the city.

Some of the loss is by radiation, and the amount of tolerable radiation is limited by the FCC. The use of triple shielded coaxial cable for all main cables has reduced loss through radiation to tolerable limits. The use of triple shielded cable also helps solve another problem; pickup of interference and noise by the cable itself. It is well known that there are many sources of radio interference in an average city, i.e., electric shavers, automobiles, etc. To lessen random noise, the signal to noise (or interference) ratio must be large. Also, any interference that may be present must not be allowed to enter the cable. The interference problem is uppermost in the minds of those working on the cable. One poor junction, connecting a subscriber to the main cable, can allow automobile ignition noise and other interference to enter the cable and ruin reception for blocks.

Problems Facing The Cable Service Operator

The problems facing the Ithaca cable service are both technical as mentioned above, and financial. Since the service is out to make a profit, and since it would have few subscribers if its rates were too high, costs are an all important consideration. There are two aspects to the cost picture. The first of these may be termed equipment costs, and the second comes under the heading of operating costs.

The cable service is quite expensive from an equipment standpoint. First there is the cost of the cable. The price of the triple shielded cable used for all main cables is about 120 dollars per 1000 feet. The light cable used for the run from subscriber's home to branch cables costs about fifty dollars per 1000 feet. In addition, the need for amplifiers along the cable introduces an additional expense of from 200–700 dollars for each amplifier, depending on the size of the amplifier. In addition, there is the cost of providing the two

mountaintop reception points and the links from the mountaintops to the central distribution point. Finally there are the expenses associated with maintaining all this equipment.

In any business, the major operating expenses are usually attributable to labor costs. It is in this area that the Ithaca cable service has been able to effect considerable savings. The main distribution point and both hilltop receiving installations are unattended. Equipment reliability and operation are such that the sites need to be visited only about once in five months. The decision of which five of the nine available channels are to be sent to the central distribution point from the hilltop sites during each hour of the day is made in advance with the aid of published program guides. Switching signals for this purpose are sent via a telephone line to the antenna sites. These switching instructions originate from an ingenious clockwork mechanism located in the downtown office. Thus the cable service is operated virtually without supervision twenty-four hours a day.

The cable service originally ran nearly all of its lines on telephone company poles. For this privilege, it paid a yearly rent of three dollars per pole. However, due to a recent rent increase, and due to the fact that the phone company is in a position to govern what the cable service sends over cable on phone company poles, a policy change has been made. Because the cable service at present, feels "at the mercy" of the phone company, it is effecting a changeover to the use of poles owned by the cable service. Any new poles used are put in by cable service men. At the present time, sixty percent of the poles used, still belong to the phone company, and the changeover is still in process.

The cable service must be franchised by the City, Town of Ithaca, and Village of Cayuga Heights. It must pay franchise taxes and also a federal tax on each installation similar to that paid by the telephone company.

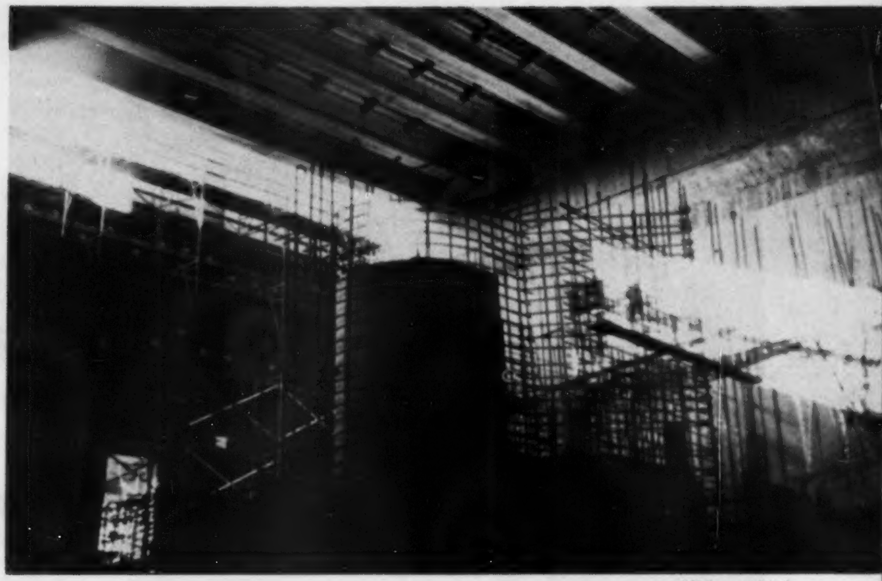
Seven hundred communities in the country have solved their TV reception problems in a manner similar to that employed in Ithaca. Of these seven hundred cable services, Ithaca's was rated "best" in a recent RCA survey, according to Mr. Pyle, cable service manager.

Mr. Pyle has also spoken proudly of the fact that Ithaca's system is used as a model by many towns interested in their own cable services. The Ithaca service has pioneered in some of the techniques now used by services throughout the country, and the results of Ithaca's early work are being applied in commercial devices manufactured specifically for cable services.

The Ithaca cable service allows everyone in Ithaca to reap the benefits of an ideal mountaintop antenna site. The entire system, from mountaintop to television set represents an interesting and ingenious engineering solution to a difficult problem; fringe-area television reception.

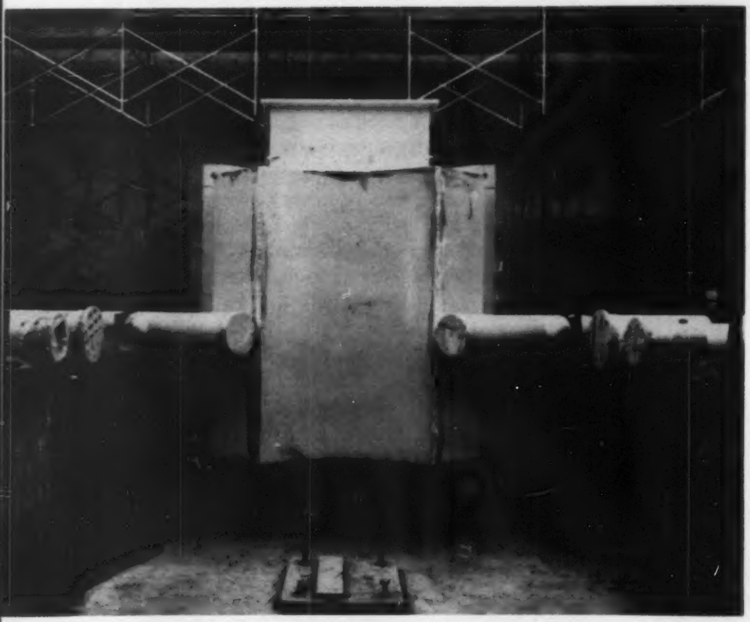
Ed Schulman

Arrival of part of the training reactor. The name, TRIGA, stands for Training Research Isotope General Atomic.



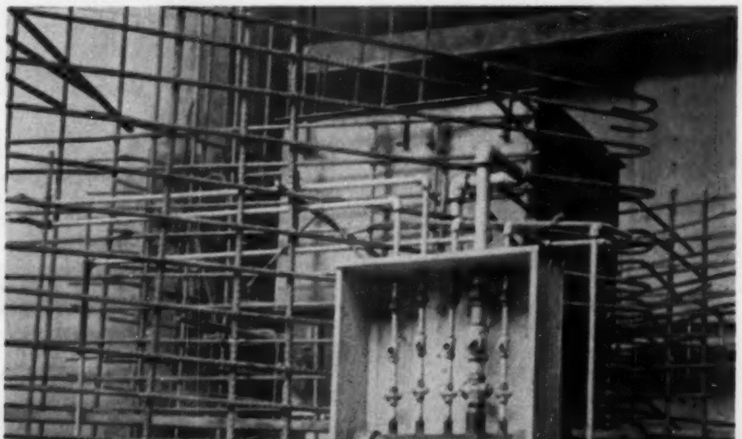
Mickey Schlick

Construction of 25 ft. deep pool that will surround training reactor showing steel reinforcing bars for concrete.



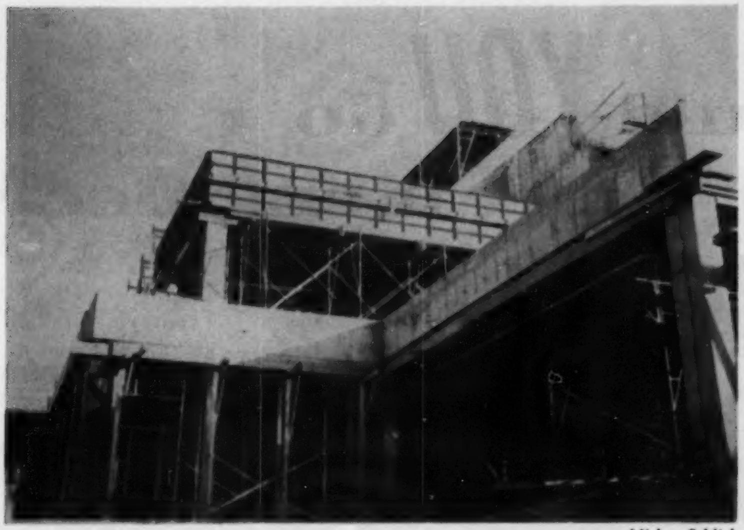
Training reactor in process of construction. Thermal column is in center with beam ports on either side. Core of reactor will be placed just in front of the thermal column and the entire reactor enclosed in concrete pool and filled with water.

Gary K. Cowell



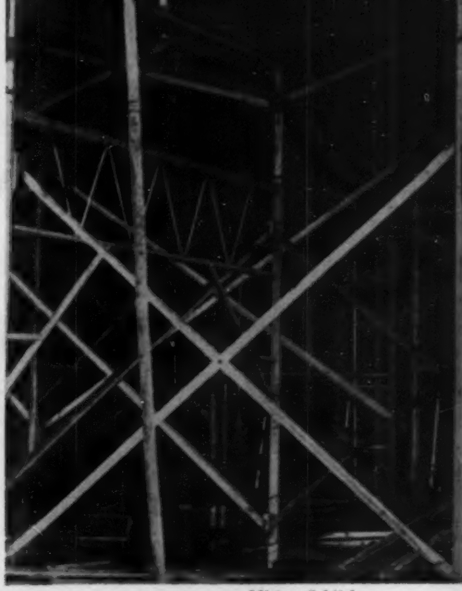
Thermal column for reactor surrounded by forms for concrete. Boxed section in center contains venting pipes for thermal column.

Ed Schulman



Mickey Schlick

Exterior of reactor facility showing construction of right, front corner. The front portion will contain two stories and a basement filled with offices, labs, and maintenance equipment.



Mickey Schlick

Scaffolding used during construction of reactor.

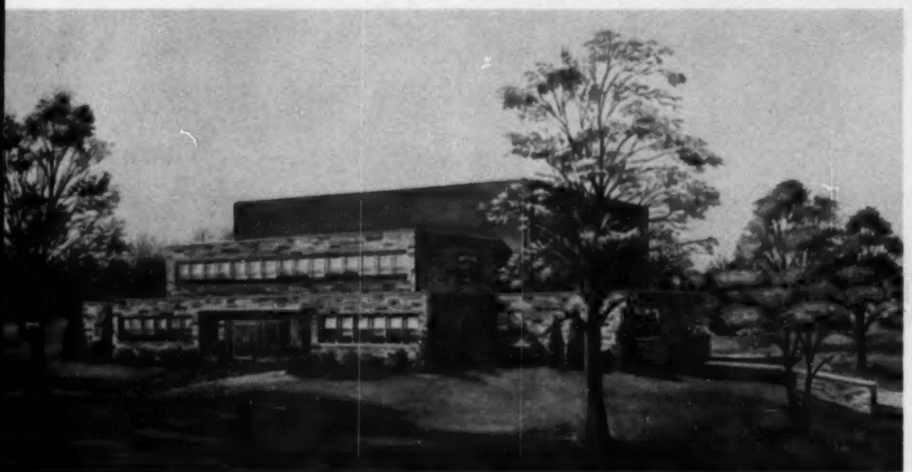
CORNELL NUCLEAR REACTOR

Construction crews are presently working day and night to complete the Cornell Nuclear reactor which is scheduled for operation in June of this year. The facility, which is taking shape behind Kimball-Thurston and Upson Halls, will house two reactors and a gamma radiation cell. One of the reactors will be a training reactor for the study of radioactive isotopes, the other will be a zero-power reactor for studying the basic mechanisms of the self-substaining reactor process and will have a modified critical assembly to allow experiments on the reactor itself to be made.

The facility was designed by Vitro Engineering Company in cooperation with Cornell and will be under the direction of Professors T. R. Cuykendall and D. D. Clark when completed.

Ed Schulman

Crane lifting beam to complete roof construction.



Dept. of Engineering Physics

Sketch of nuclear reactor facility as it will look from steps on side of Kimball-Thurston Hall.

Pratt & Whitney Aircraft?

Regardless of your specialty, you would work in a favorable engineering atmosphere.

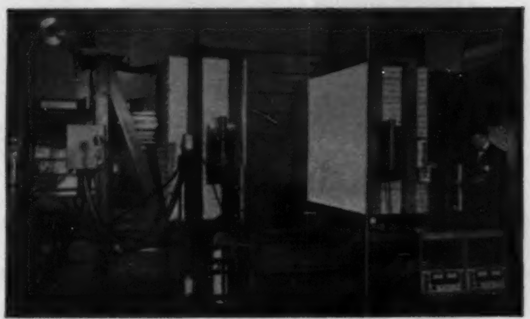
Back in 1925, when Pratt & Whitney Aircraft was designing and developing the first of its family of history-making powerplants, an attitude was born—a recognition that *engineering excellence* was the key to success.

That attitude, that recognition of the prime importance of technical superiority is still predominant at P&WA today.

The field, of course, is broader now, the challenge greater. No longer are the company's requirements confined to graduates with degrees in mechanical and aeronautical engineering. Pratt & Whitney Aircraft today is concerned with the development of all forms of flight propulsion systems for the aerospace medium—air breathing, rocket, nuclear and other advanced types. Some are entirely new in concept. To carry out analytical, design, experimental or materials engineering assignments, men with degrees in mechanical, aeronautical, electrical, chemical and nuclear engineering are needed, along with those holding degrees in physics, chemistry and metallurgy.

Specifically, what would *you* do?—*your own engineering talent* provides the best answer. And Pratt & Whitney Aircraft provides the atmosphere in which that talent can flourish.

For further information regarding an engineering career at Pratt & Whitney Aircraft, consult your college placement officer or write to Mr. R. P. Azinger, Engineering Department, Pratt & Whitney Aircraft, East Hartford 8, Connecticut.



At P&WA's Connecticut Aircraft Nuclear Engine Laboratory (CANEL) many technical talents are focused on the development of nuclear propulsion systems for future air and space vehicles. With this live mock-up of a reactor, nuclear scientists and engineers can determine critical mass, material reactivity coefficients, control effectiveness and other reactor parameters.

Representative of electronic aids functioning for P&WA engineers is this on-site data recording center which can provide automatically recorded and computed data simultaneously with the testing of an engine. This equipment is capable of recording 1,200 different values per second.

Studies of solar energy collection and liquid and vapor power cycles typify P&WA's research in advanced space auxiliary power systems. Analytical and Experimental Engineers work together in such programs to establish and test basic concepts.

PRATT & WHITNEY AIRCRAFT

Division of United Aircraft Corporation

CONNECTICUT OPERATIONS — East Hartford

FLORIDA RESEARCH AND DEVELOPMENT CENTER — Palm Beach County, Florida


U.S. ARMY

FIFTY YEARS AGO IN THE ENGINEER

Edited by Bob Solomon, EE '64

The Cornell Aero Club was organized "to promote the investigation and study from a theoretical and practical standpoint, of the science of aeronautics" at Cornell University. This can be accomplished in several ways, i.e., by lectures before the club, discussions in the club, and actual experimentation.

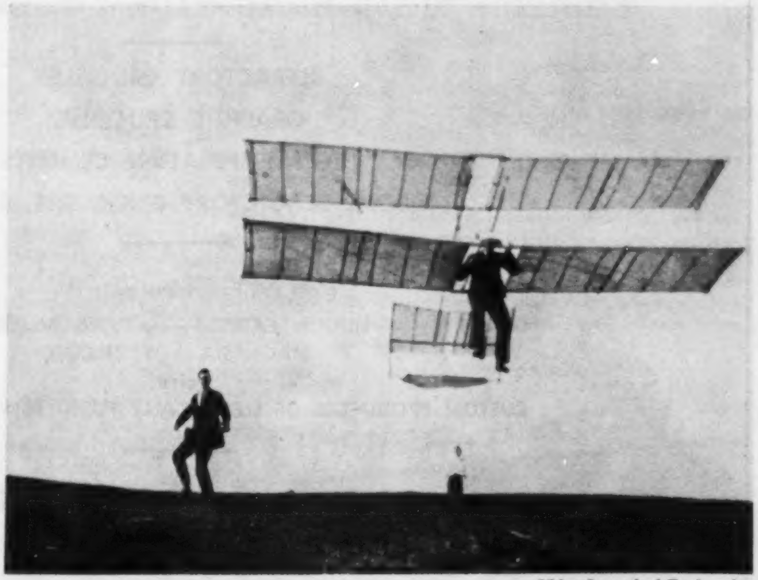
As with all others, the Cornell Aero Club's great desire is the attainment of mechanical flight. This is impossible, of course without an aeroplane, and as the club is young and impecunious, such an acquisition has been quite a problem until very recently, when the club finally decided to build one. As an adequate motor would necessitate very laborious application to its construction, and as the task would be almost too great for the members of the club, a subscription for one has been solicited among the undergraduates, with remarkable success, and the Aero Club is certain of possessing an aeroplane next Spring.

Through the efforts of the club, the faculty of Sibley College will inaugurate a course in aerodynamics next fall . . . . The Aero Club, however, appreciating the value of speedy action, has inaugurated a course of its own, the official title of which is, "Glider Construction and Manipulation."

The objects of this course are: first, to prepare for and create interest in the course to be given by Sibley College next year; second, in persuance of the policy of the club, to teach the undergraduates as much as possible of the science of aeronautics and its practical applications; third, to provide for them the next thing to a real flight, instruction in soaring or gliding; and fourth, to prepare them for actual flights in the aeroplane next Spring.

The Course will be divided into three branches. There will be a lecture given twice a month, by which the students in the course will be taught simple aerodynamics, points in construction, and in manipulation. There will be a laboratory or construction period twice a month during which the students will actually construct the machines which they use. The third part of the course will be in the nature of experimental work. There will be two periods a week presumably of one hour each, during which the students will be taught by means of towed flights, first, to keep their forward balance, and then by means of one tow-rope, to keep their lateral balance, also; all by means of adjustable planes or other similar devices. The preceding work will be taken up on level ground, but, after the operator has become proficient, he will be towed down a slight incline, and finally, allowed to attempt free flight down a steep slope. It is hoped to have contests of skill in operation of these gliders in the Spring. *The Sibley Journal*—December, 1910.

Considerable water has run under the bridges and past the hydraulic laboratory since the publication (in 1899) of articles in engineering magazines and transactions of engineering societies describing the construction of this unique part of Cornell's visible equipment.



Sibley Journal of Engineering

Glider practice by students.

It is one thing to idealize and another to realize. The scope of the ambitious imagination is considerably less limited than the boundaries of subsequent achievement. Even so with our laboratory.

Since 1899 only the last five years have witnessed the use for regular instruction purposes of our Fall Creek laboratory building, the work previously having been carried on in Lincoln Hall basement, except for some senior elective work at the laboratory canal. During these five years the development has been slow but in the aggregate, considerable. The inadequacy of the original general design of the canal and building for instruction and investigation has made progress unnecessarily difficult.

The installation of equipment under the circumstances has been held back by the feeling that a really satisfactory hydraulic laboratory with the present arrangement of canal and building is out of the question. Yet, at the same time, there are some very pressing needs of the rapidly passing procession of students that, it is felt, should be met somehow without waiting for a millionaire to advance the necessary money for a new laboratory, "than which a more unique monument in a more beautiful natural setting would scarcely be wished".

So we have been renewing hope and plodding along. *The Sibley Civil Engineer*—December, 1910.

The lifting magnet seems to have taken a peculiar grip on the popular imagination, and its use has been eagerly suggested for all varieties of applications. Recently I had a letter from China asking if a magnet could be furnished for removing bullets from the bodies of persons who had been shot. Lifting magnets have been successfully used for salvage operations, and not long ago we furnished a magnet for picking up and loading iron ore in the form of large chunks of magnetite.

The question of safety is frequently raised, and during the time when the magnet was being commercially introduced, its use was frequently combated on the score that it was dangerous to workmen. Of course it cannot be denied that if a man is standing under a magnet that is carrying a load and the circuit is interrupted, something is going to happen to that man. I maintain, however, that it is safer to use a magnet for the transportation of material than to use chains, for several reasons. First, the magnet is inherently a labor-saving device, and when it is used the number of laborers in its vicinity is largely reduced and frequently the magnet entirely displaces ground labor. Second, a laborer always looks upon a magnet with a high degree of suspicion, since there is nothing tangible to hold up the load, and he avoids getting under a load supported by a magnet more than he would getting under a load supported by chains; in other words, he uses more caution. Third, the accidental opening of a magnet circuit probably does not occur as often as the slipping or breaking of chains supporting a load. *The Sibley Journal*—December, 1910.

CERAMIC ADHESIVES

NEW BONDING MATERIALS NEEDED FOR TODAY'S HIGH TEMPERATURES

by Charles K. Betz, ME '62

Modern technology has developed many new special purpose materials. The recent emphasis on aircraft design and rocketry has brought about the development of many of these new materials. As a consequence of this development, new adhesives have been developed to bond these materials together.

Adhesives were first used in the bonding of metals in the aircraft industry. Presently, other industries are finding applications for this use of adhesives. This has been due to several distinct advantages which adhesives offer over other fasteners:

Leak-proof joints are produced, and resultant assemblies are usually lighter than those using conventional fasteners (bolts, rivets, etc.); stress is more uniformly distributed which increases structural effectiveness and resistance to fatigue. Many adhesives are corrosion resistant, and dissimilar metals may be joined easily. High temperatures are not required during joining; vibrations are more effectively damped.

At first, organic resins were used in metal joining. These are usually classified by the type of organic resin they contain. Basically, these resins are chain-like molecules which achieve their adhesive properties as a result of chemical polymerization reactions. Thermosetting resins (those which remain hard and infusible after curing but which decompose if exposed to excess temperatures) form three-dimensional networks resembling a giant molecule, tied together with crosslinks. On the other hand, thermoplastic resins have few or no crosslinks and may be repeatedly melted and reformed.

The temperature requirements of many adhesive applications in the missle and aircraft industry have exceeded the upper limits of organic resin base adhesives. For this reason, inorganic adhesives have been receiving considerable attention lately for these high temperature applications.

Low Temperature Adhesives

A great variety of low temperature adhesives are some form of silicate, the best known probably being sodium silicate. The adhesive properties of liquid sodium silicates are useful in setting adhesives, the silicates are ideal for combining and laminating paper, fiber board, and asbestos products. The latter of these makes use of the incombustability of silicates. Other important uses include the production of plywood, wall board, and insulation products.

Proper wetting of the surface is the first step in silicate adhesion. This is due to the fact that the bonding agent must establish very intimate contact with the outer layers of the material to be joined, i.e., the adhesives must completely cover the area to facilitate interlocking of the surface irregularities to provide "hooks" that may grip the surface and hold it tightly. There is much more to adhesion than this but this is the general purpose of wetting. The wetting

time of sodium silicate is affected by its viscosity. The liquid silicates range from slightly sticky fluids of maple syrup consistency to very viscous materials of taffy consistency.

Setting time is often an important factor in choosing an adhesive. Silicates set rather quickly through the loss of a small amount of water. This water is lost by evaporation and by absorption into the materials to be joined. Wetting and setting time is often held up when the silicate adhesives are applied to highly sized papers, metals, or other smooth surfaces. Often this may be remedied by the addition of surface active agents. Some of the agents which have been used with success are: bile acids, rosin soaps, sulfates, and sulfonated castor oil.

The strength of the silicate bond is fairly high. Silicate films provide tensile strengths of 1000 psi. This is more than sufficient to grip the materials for which it is usually used. "In an experiment, a silicate bond used to adhere walnut wood blocks, exhibited a strength of 400 to 700 pounds per square inch after drying for 28 days."

One major disadvantage of silicate bonds is the effect which water has on them. They show some resistance to moisture but are not waterproof. Water resistance may be improved, however, by adding small quantities of zinc oxide, calcium carbonate, or magnesium oxide.

Several organic synthetic resins may be combined with sodium silicate. Such mixtures also exhibit improved water resistance. Looking at it from the opposing viewpoint, the addition of sodium silicate to organic resins improves their fire resistant properties and lowers their cost in most cases.

Medium Temperature Bonds

Most of the intermediate temperature range ceramic adhesives are based on the phosphates. Aluminum phosphates have proved to be valuable binders for refractory materials. The reaction of Tabular Aluminia (a product of Alcoa) and phosphoric acid produces an aluminum phosphate bond which results in higher bond strength than is obtained by direct addition of the equivalent amount of aluminum phosphate. Strengths exceeding 4000 psi are developed and retained through the refractory range of temperature to 3400°F. Very good resistance to erosion is also maintained at these temperatures.

High Temperature Adhesives

For high temperature applications, ceramic adhesives are a must. Even the most heat resistant of the organic adhesives breaks down at temperatures in excess of 500°F. Most of the ceramic adhesives can be designed for any temperature range up to presently required temperatures.

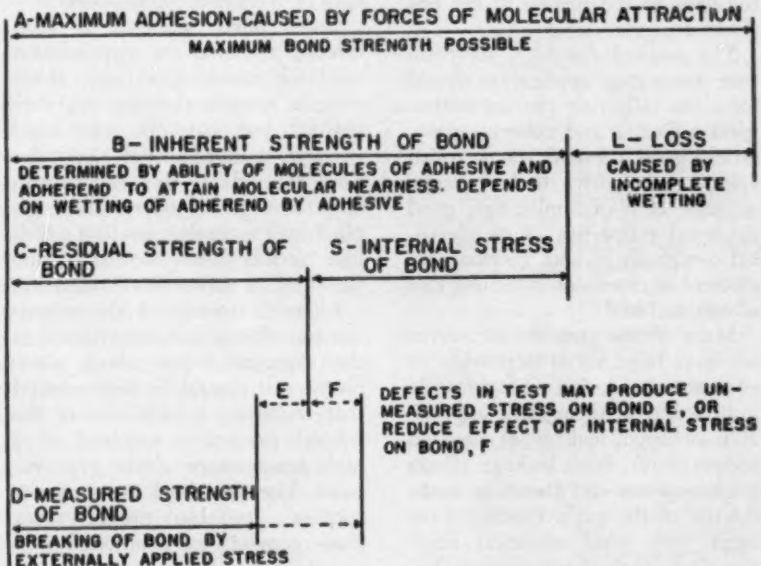
Several high temperature glasses and mineral materials have higher melting temperatures than do the silicates and phosphates previously referred to. One such high temperature glass is lead bisilicate which has a melting range of 1450°–1500°F. This glass and several similar lead glasses have been used extensively as adhesives in seals. These are sometimes referred to as "solder glasses." Several leadless glasses have also been used in various sealing operations. One member of this category is a magnesia-aluminosilicate eutectic which has a melting point of 2200°F.

One of the most promising new mineral materials to find use as a ceramic adhesive is nepheline syenite. Nepheline syenite is a white igneous rock, resembling granite in texture and hardness, in the crude form. This rock consists mainly of feldspar and nepheline. The crude rock is crushed and ground to a granular sand size at which point minor iron minerals are removed. Following this operation, it is further ground to various grades of powder from 200 mesh to even finer sizes. This material starts to sinter at 1735°F. To fuse this material requires further heating to about 2650°F. This long sintering range plus high viscosity above the temperature at which it is densified to glass makes nepheline syenite a rather good high-temperature adhesive.

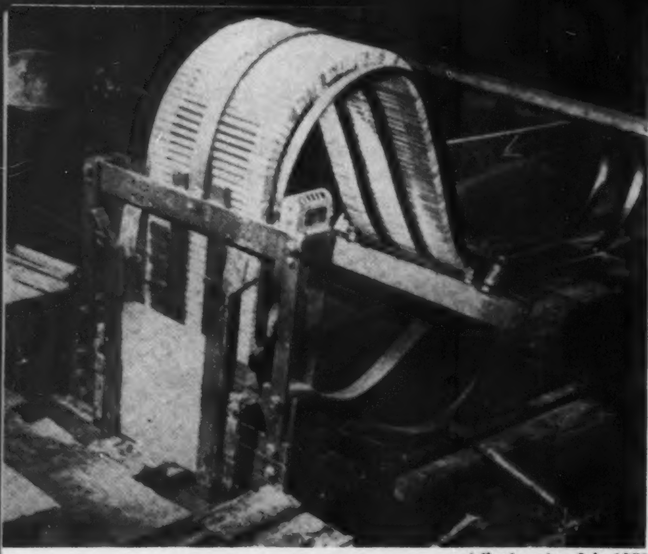
Strain Gage Adhesives

The emphasis on elevated temperatures, which has been brought about by the aerodynamic heating effects on fighter aircraft and missiles traveling at supersonic speeds in the dense atmosphere, is increasing. This and the lack of data dealing with the properties of structural materials at elevated temperatures, aroused an acute interest in high temperature strain measurement.

Figure 1—Relations Between Factors Involved in Adhesion



Adhesives Age July 1959



Adhesives Age July 1959
The application of sodium silicate adhesive to the ends of these wooden strips permits the adherence of felt strips.

Adhesives Age July 1959
On this tube winding production line, sodium silicate adhesives are used to produce tubes of up to 24 inches in diameter.

The maximum temperature at which the wire resistance paper-backed strain gages will operate is about 350°F. Above this temperature, most of the organic cements used for this application deteriorate. For high temperature applications, the use of ceramics in place of organics has had to be adopted.

The work on ceramic bonded strain gages has been under way since 1955. From this investigation, a new gage, called the 5B design, which gives usable static strain data up to 900°F, has been developed. This gage consists of two straight .001 inch diameter wires, ⅜ inch in length. They are coated with a thin layer of ceramic cement which is also used to attach the gage to the surface of the test structure.

The cement for high temperature strain gage application should have the following characteristics: good adhesive and cohesive properties, good thermal shock resistance, non-corrosive to base metal or gage, ease of application, good electrical properties (high electrical resistance), and thermal coefficient of expansion matching that of test material.

Many of the cements in current use have been found to provide an adequate bond, but unfortunately quite a few of them show appreciable electrical leakage at elevated temperatures. Such leakage affects gage response and therefore limits the use of the gage. Finding a cement with good electrical resistance at high temperatures has been a major problem for the past few years.

The main purpose of a recent investigation was to develop ceramic cements which have higher resistivities in the range of 1000 to 1800°F than any of the high temperature adhesives currently used. To achieve this goal, a large number of ceramic fillers and bonding agents were used.

The ceramics that had the highest resistivities were: alumina, beryllia, magnesia, thoria, silica, and mica. The bonding agents used were: phosphoric acid, mono-aluminum phosphate, calcium aluminate, potassium silicate, and clay. Thirty different experimental cements were tested and compared with nine commercial products.

Good bond strength is considered essential in any cement used for attaching a gage. However, a cement showing high resistivity but virtually zero bond strength to the Inconel electrodes used throughout this experiment, might still give good results if applied over a ceramic coating which had already been bonded to the metal by an earlier heat treatment.

Although several of the experimental ceramic adhesives tested in the experimentation above show promise, it should be remembered that resistivity is only one of the several properties required of a high temperature strain gage cement. Thermal shock resistance is another desirable property for these cements as mentioned previously. Several commercial ceramic adhesives are excellent for applications where thermal shock is a consideration.

One cement has been used extensively on all common metals used in jet engines with the exception of those with low thermal coefficients of expansion. For these materials, another bond is used because of its low expansion coefficent. Both of these cements will withstand repeated thermal shock from 1500°F to cold water, and excellent results are obtained in service.

The cement used may have the effect of either preventing or promoting corrosive attack on the gage wires. Tests to investigate this effect of several cements have been made. Changes in resistance with time at 1400°F for Nichrome V wires that were imbedded in several ceramic bonding agents were noted. The small increase in resistance of uncoated wire with time is believed to be caused by reduction of cross sectional area due to oxidation. The cement mentioned previously was found to protect the wire from the oxidizing effect. Several sodium silicate bonding agents were found to promote a corrosive attack on the wire at temperatures exceeding 1200°F. This prohibits these bonding agents for high temperature strain gages.

Useful Properties

Brittle ceramic coatings for experimental stress analysis have been receiving much attention in

the past few years. One of the most convenient methods for determining stress distribution in an unknown stress field is employing brittle coatings which crack at right angles to the principal strains. The most successful of these brittle coatings have been brittle lacquers but they break down at elevated temperatures and high humidity.

Resin based coatings were made commercially available in 1940 but they were limited in operation to temperatures up to approximately 100°F.

In 1952 Singdale reported on the development of porcelain enamel coatings that could be used as brittle coatings for experimental stress analysis. These ceramic-base materials will operate from approximately −50 to 600°F in a sensitivity range of 200 to 1800 micro-inches per inch. Changes in temperature and humidity did not appreciably effect test results.

The success of ceramic coatings depends on a controlled difference in the coefficient of expansion of the coating and the base metal. If the coefficient of expansion of the coating is greater than that of the test material, residual tension will be locked up in the coating when it cools from the firing temperature. This will cause the coating to crack at low strain levels. The reverse of this phenomena is also true. If the coefficient of expansion of the coating is greater than that of the base metal, residual compression will be present in the coating which will require higher strain levels to start crack patterns. For this reason calibration bars for the coating are much more practical if they are made from the same material as that which is to be tested.

Until lately, scientists have felt that ceramics are inherently brittle. Recently, several scientists at the University of California, under the direction of Earl R. Parker, have found that some ceramic materials exhibit ductile properties. Most of the work in this field has been done on single crystals and practical application of discoveries is still way off. As an example of these studies, one ductile material that Parker found is magnesium oxide. It melts at 5000°F and has a ductility comparable to tungsten. These ductile ceramics when used in adhesives and coatings of the future might be valuable to coat materials with high thermal coefficients of expansion.

Recently, ceramic coatings have been successfully applied to a wide range of metals to increase their heat and corrosion resistance. Tests have been run resulting in coatings which will withstand brief heats up to 5000°F.

Quartz is often used to give the coatings heat resistance. Its main disadvantage, however, is that it will not bond at high temperatures. This problem has been solved by making the bond with lower temperature coatings and then spraying the surface with some refractory such as alumina.

Highly emissive or highly reflective coatings can be made by proper choice of refractory. Emissive coatings are those which help to dissipate heat from metal. Reflective coatings turn back, or reflect, some of the heat that would otherwise reach the metal. Coatings exhibiting high emissive and low reflective values are dark in color and have a rough surface. Nickel oxide, chromic oxide, ferrosilicon, and chromide are commonly used in this type of coating. On the other hand, coatings with the highest reflectivity or lowest emissivity are usually made with large amounts of dense white oxides. Zirconium spinel and Treopax are commonly used.

One of the more promising super-refractory materials is boron nitride. Pure boron nitride is a white powder consisting of microscopic flakes, similar to those found in graphite. These platelets can be pressed into a dense material of various shapes.

The General Electric Co. has done much experimentation on boron nitride recently. Under extreme pressure and heat the G. E. scientists have succeeded in converting the normal hexagonal BN structure into a cubic form. This new form exhibits superior mechanical strength and is highly stable at elevated temperatures.

In order to use boron nitride or similar super-refractory materials having high melting points in ceramic coatings, it is necessary to incorporate into them powerful fluxing materials which will counteract their influence on the firing conditions under which the coatings are applied. This requires a careful choice of fluxes to prevent weakening of the coating or base metal, and excess weight of the coating. Several good fluxing agents are available: molybdenum trioxide, strontium oxide, barium oxide, and many lithium compounds. Several of these fluxes also serve as elevated temperature wetting agents.

One of the newest superalloys used for missiles is magnesium thorium. This material is lighter and stronger than either aluminum or magnesium, however, one of its big disadvantages has been its relative softness. To overcome this drawback, ceramic coatings have proved successful. They are a lot harder than many forms of steel and these coatings can be given greater wear resistance by adding special abrasive resistants.

We are on the threshold of the development of these new versatile ceramic adhesives and coatings. With a few changes, the same coating that is used on a coal chute can increase the life of a launching platform for guided missiles. Others can make auto mufflers last as long as the cars they are used on. At this point there does not seem to be any end to the possible applications of ceramic adhesives and coatings.

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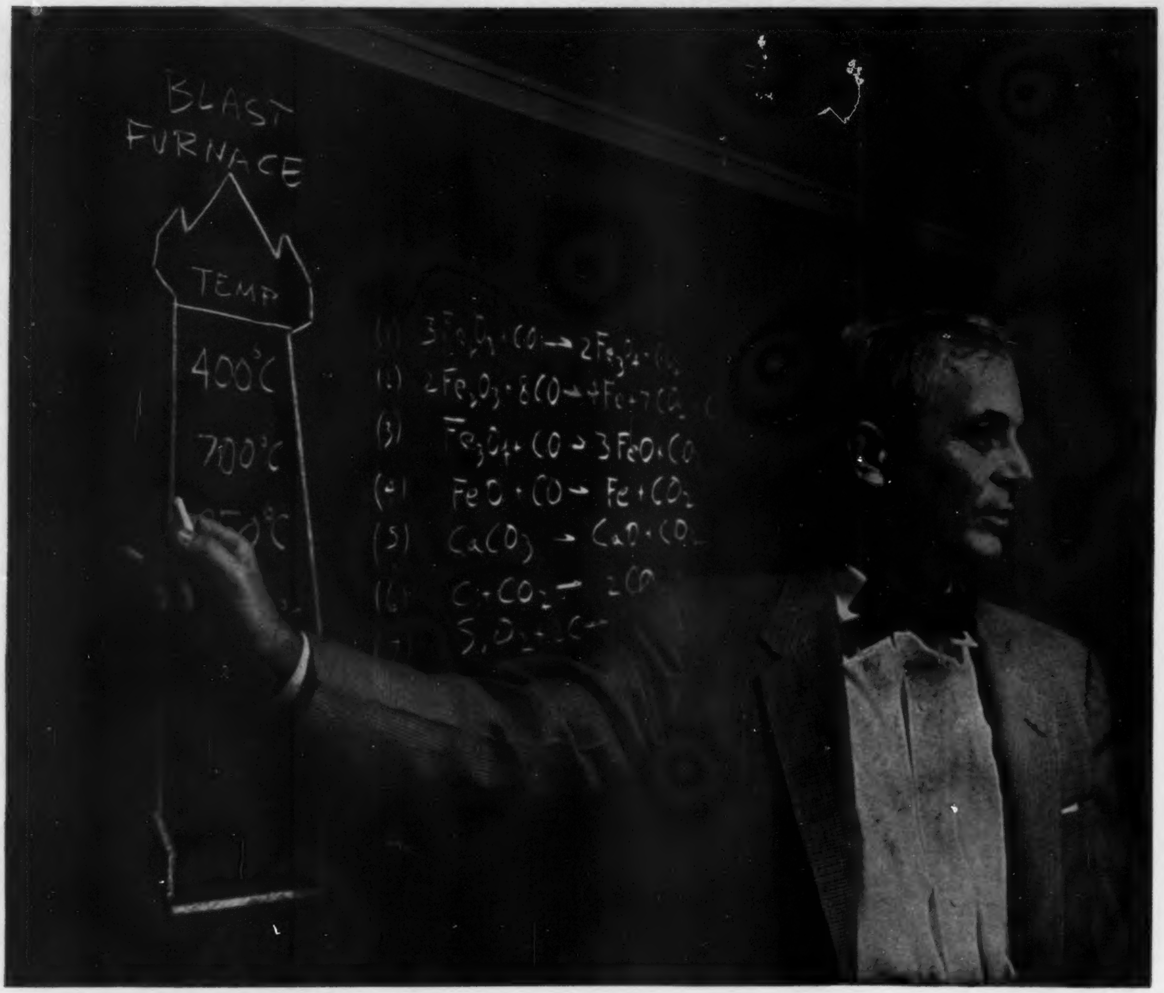
The author would like also to express his appreciation to Dr. John H. Koenig, Director of the Rutgers University School of Ceramics, for his assistance on this subject.


BLAST
FURNACE
TEMP
400°C
700°C

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107 EAST 48TH STREET 1960-61 NEW YORK 17, N. Y.

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"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students, and to establish closer relationships between the College and its alumni."

THE PRESIDENT'S LETTER—

We had an excellent dinner meeting in New York on November 30 during the annual meeting of the A.S.M.E. A number of out of town members attending the A.S.M.E. meeting were present, including Director Harry J. Loberg of the Sibley School of Mechanical Engineering and Professor Edmund T. Cranch, Head of the Department of Engineering Mechanics and Materials at Cornell.

Following the dinner, Professor Cranch spoke on the subject of "Engineering Mechanics and Materials at Cornell." He traced the development of the present department that he heads and outlined the future developments in this field as he views them, with particular reference to the new Material Science Center now being organized at Cornell under Professor Robert L. Sproull, as Director. As you probably know, this new Center is being established under a contract that will bring substantial financial support from the U.S. Department of Defense Advancement Research Project Agency for the first four years. Professor Cranch's discussion stirred up so much interest that the Question and Answer period carried on for a full hour.

The next meeting in New York is scheduled for Wednesday evening, February 1, 1961. This meeting has been scheduled during a meeting of the A.I.E.E. so that, out of town members attending the A.I.E.E. meetings will be able to join in.

John Gnaedinger, President of the Chicago Chapter tells me that they are planning their next meeting in January, the exact date has not yet been set, and the subject of their discussion will be Industrial Relations. They also have plans well along for a joint meeting with the Cornell club of Chicago during the Spring vacation period. At this meeting they plan to entertain both the prospective freshmen and their parents and the undergraduates who will be home on vacation.

Paul O. Gunsalus

ALUMNI ENGINEERS

Seymour W. Ferris, B.Chem. '22, is a research associate with Sun Oil Company. He entered the research department of the Atlantic Refining Company in 1923 and joined Sun Oil in 1945. He is a member of the New York Academy of Sciences and Franklin Institute; he has had numerous patents and articles in the field of petroleum technology.

Robert B. Gear, E.E. '28, was elected a director of the worldwide American Institute of Electrical Engineers at the Institute's annual meeting. Mr. Gear has been with Commonwealth Edison of Chicago since graduation except for four years with the Army Corps of Engineers during World War II. He was made director of purchasing in 1954.

Alan Cohen, B.C.E. '55, is now vice-president of Joseph S. Ward and Associates, Inc., consulting soil and foundation engineers in Philadelphia.

Mr. Cohen heads the Company's new soil testing laboratory which is to be used for soil and foundation investigations for building projects in the Philadelphia area. He received his Master's degree in civil engineering from M.I.T., in 1956. He is a former Air Force installations officer. He is a registered professional engineer and a member of the Cornell Society of Engineers. Before joining the Ward firm, Mr. Cohen worked with the firm of Moran, Proctor, Mueser, and Rutledge, in New York City.

George C. Brainard, M.E. '11, retired recently from the service of Addressograph-Multigraph Corporation of Cleveland, Ohio. He was chairman of the executive committee and a director of the Corporation. Mr. Brainard had been president of Addressograph-Multigraph from 1946 until June, 1952, when he was made executive committee chairman. A native of Danvers, Mass., he studied engineering at both Northwestern and Cornell. He started his career as an engineer with R. B. McMullen in Chicago in 1909. In 1914, he joined Hydraulic Pressed Steel Co., Cleveland, as sales engineer. During the following nine years, he served successively as their chief engineer, factory manager, and general manager. In 1923, he accepted employment with General Fireproofing, and in twenty-two years he rose to vice-president and president. He is still chairman of General's executive committee and is a director. In addition, last May he was reelected president of the Holden Arboretum, whose 1700 acres help to adorn the city of Cleveland.

Dr. James W. Moyer, A.B. '38, has been appointed research director of the Sperry Rand Research Center, to be built later this year in Sudbury, Mass.

For the last twelve years Dr. Moyer has been associated with the General Electric Company in technical long-range planning and research posts involving advanced study in the fields of semiconductors, optics, spectroscopy, and physical chemistry. He holds patents and has had articles published in professional journals in these fields. During the last four years, he has also served as a consultant to the National Bureau of Standards, contributing directly to the Bureau's Free Radicals Research Project. Between 1941 and 1946 he held various civilian scientific posts with the Tennessee Eastman Company at Oak Ridge, Tenn., University of California at Berkeley, and the War Department's Rochester Ordnance District.

Sperry Gyroscope Co.
Dr. James W. Moyer

Dr. Moyer received his A.B. degree from Cornell in 1938, and his Ph.D. from the University of Rochester in 1948. He is a member of the American Physical Society, American Rocket Society, and the Philosophical Society of Washington, D.C.; he is a senior member of the Institute of Radio Engineers.

Dr. Robert W. Perry, B.M.E. '43, M.M.E. '47, Ph.D. '51, is now chief of the research and development re-entry simulation laboratory at Republic Aviation Corporation. Before joining to Republic, Dr. Perry worked with ARO, Inc., contract operator of the U.S. Air Force's Arnold Engineering Development Center. Dr. Perry has also worked as an instructor in mechanical engineering at Cornell. He is currently a member of the National Aeronautics and Space Administration Research Advisory Committee on Fluid Dynamics, the Institute of Aeronautical Sciences, the American Rocket Society, the American Society of Mechanical Engineers, and Sigma Xi. Dr. Perry is a registered engineer in New York and Tennessee.

John V. Prestini, B.S. in A.E. '36, has been appointed sales manager, wheel products, for the Budd Company. Mr. Prestini assumes complete charge of sales of Budd wheels and related products, including hubs, drums, and brakes. He is also in charge of all operations of Wheel Industries, Inc. on the Pacific coast. Mr. Prestini has been with the Budd Company since 1945 in the sales department in Detroit. After he graduated from Cornell in 1936, he held engineering posts with Packard Company, U.S. Rubber Company, and Chrysler Corporation.

He is active and well-known in automotive circles in Detroit, and is a member of the Society of Automotive Engineers, Cornell Society of Engineers, Detroit Athletic Club, and Red Run Golf Club.

preferably...
a big FISH in the right-sized STREAM

We've been told frequently that engineering graduates are attracted to a company our size because of an honest and understandable desire to be "a big fish in a little pond". Perhaps others prefer to think of the future as the challenge of "swimming up-stream".

We believe that Sikorsky Aircraft is actually the "right-sized stream" for young engineers who would enjoy diversified, small-group activities, as well as stature opportunities in a field that is not limited nor professionally confining. Sikorsky Aircraft is the company which *pioneered* the modern helicopter; and our field today is recognized as one of the broadest and most challenging in the entire aircraft industry.

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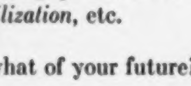
And what of your future?

That, of course, involves your own potential for growth. As a far-sighted company, we're more than willing to help you meet the challenge of "going up-stream"!

For factual and detailed information about careers with us, please write to Mr. Richard L. Auten, Personnel Department.

SIKORSKY AIRCRAFT



DIVISION OF UNITED AIRCRAFT CORPORATION

STRATFORD, CONNECTICUT

TECHNIBRIEFS

Edited by Richard Epstein, EE '63

NEW COMPUTER MEMORY DECREASES ACCESS TIME

An electronic memory, designed to keep pace with the prodigious capacities of today's computers, has been developed by Telex, Inc.

Designed around a recording and reading head that literally flies over the surface of the information-carrying discs, the memories have marked superiority in both performance and cost over existing memory systems that are essential to present-day data processing systems.

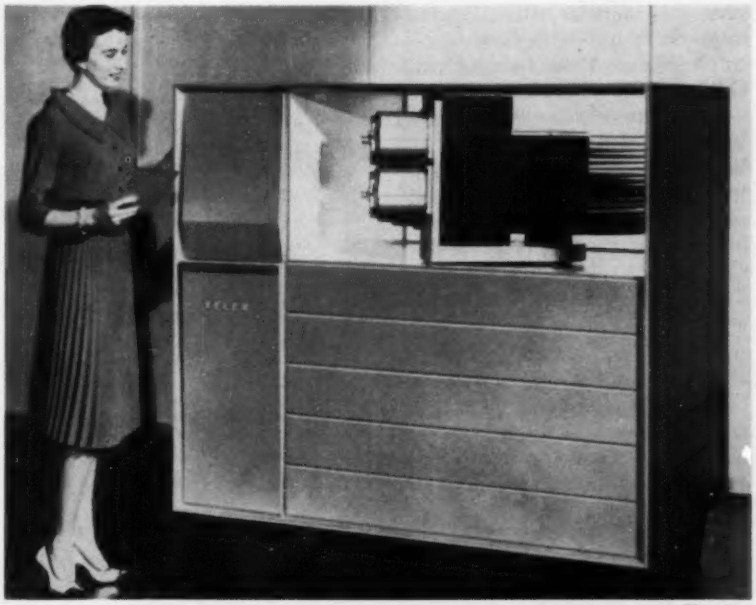
Mass memories have been the chief obstacle to increased data processing speed and efficiency. Typical of existing mass memories are the magnetic tape systems – big brothers of tape recorders – which hold about three million characters of information on a reel 2,400 feet long. To search the entire reel for an item of information takes several minutes.

In contrast, new memory unit resembles a complex jukebox. Its information is contained on from 16 to 64 discs, each 31 inches in diameter. The information is recorded on the discs and read from them in magnetic impulses by read-record heads which function somewhat like the recording and playing heads used for phonograph records.

Unlike record-player pickups, however, the Telex read-record heads never touch the surface of the recording discs. Designed like an airplane wing, the head flies on the rapidly-moving boundary air which surrounds the surface of the disc and remains about 3/10,000ths of an inch from the disc surface.

With two pair of heads and a positioning arm for each disc – one for the upper and one for the lower surface – information can be reported or extracted by directing the appropriate head positioning arm to the correct location on one of the 256 tracks contained on each recording surface.

As a result, the Telex memory has a capacity of nearly 90 million characters, consisting of seven binary digits each, compared with a 5 to 10 million character capacity of existing disc file mass memory units. Access time – the time spent in locating a certain piece of information – has been reduced from seven-tenths of a second needed by present equipment to 150/thousandths of a second. At the same time, cost is a fraction of that for memory devices of comparable performance.



Tlex, Inc.

Full-scale model of Telex I Mass Memory Module shows arrangement of discs and, to their left, the head-positioning actuators.

The new unit designed for use with all existing data processing systems, is housed in a cabinet about seven feet long, five feet high and 32 inches deep.

HIGH TEMPERATURE CARBIDE TRANSISTOR DEVELOPED

The first transistor capable of operating above 650 degrees F has been developed by scientists of the Westinghouse Electric Corporation. The new transistor is made from silicon carbide, a hard crystalline material which, in impure form, is used as an abrasive in grinding wheels.

Although still in the laboratory stages of development, the high-temperature capabilities of the new transistor make it a significant advancement in the technology of semiconductor devices. Present-day transistors, manufactured almost exclusively from germanium and silicon, can operate at temperatures no higher than about 200 degrees F (germanium) to 400 degrees F (silicon). Laboratory tests show that the new silicon carbide transistor amplifies and has power gains greater than unity up to 670 degrees F, and with further development, the Westinghouse scientists foresee its upper operating temperature at more than 925 degrees F.

Germanium and silicon transistors cannot always meet the high-temperature requirements of today's existing and planned aircraft and space vehicles. Because of its great chemical stability and de-

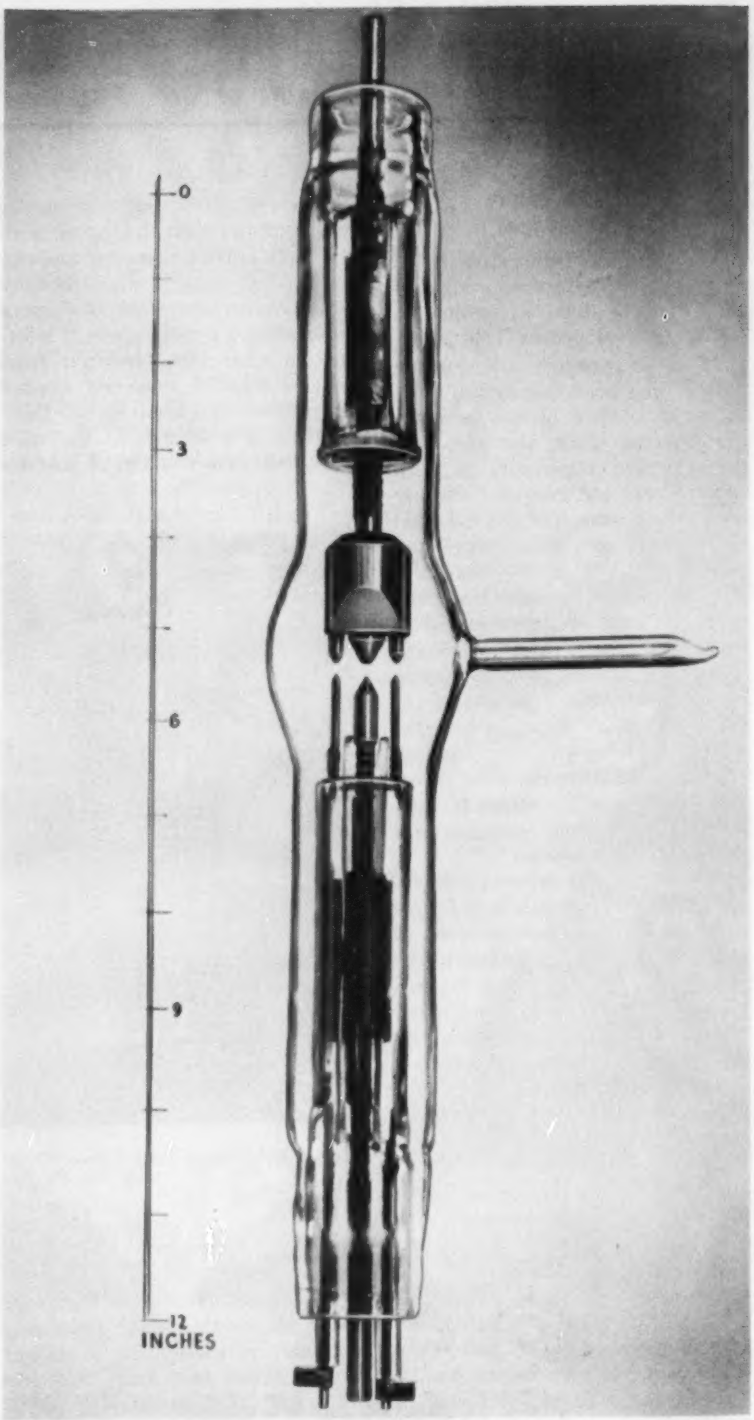
sirable electrical properties at elevated temperatures, silicon carbide is one of the most promising transistor materials for these extremely high-temperature applications.

The new device is a unipolar transistor, which differs in operating principle from the bipolar type usually made from germanium and silicon. The bipolar transistors regulate the flow of an electric current through them by the injection of electric charge carriers across a junction built into the semiconductor material. The unipolar transistor, on the other hand, acts more like a valve which opens or closes to regulate the electron flow across the junction.

Two advances have made possible the unipolar silicon carbide transistor, the Westinghouse scientists reported. They are: the availability of silicon crystals of exceptional purity, which were produced by Dr. D. R. Hamilton of the Westinghouse research laboratories; and the perfection of techniques to form the semiconductor junction in the material, and to clean, etch, solder, and otherwise handle the inert silicon carbide crystals.

The silicon carbide transistors are made from crystals about two-thousandths of an inch thick. These crystals have less than one part impurity in 10 million parts of silicon carbide. The semiconductor junction is built into the material by exposing it to vaporized aluminum at the white-hot temperature of 3900 degrees F. The aluminum atoms diffuse into the silicon carbide crystal, changing its electrical behavior from n-type material to p-type. The junction is formed where the two types meet, and the diffusion process is controlled to within a few millionths of an inch.

To construct the input and output terminals of the transistor, the wafer is etched at two points until the junction within the body of the crystal is reached. Electrical connections at these two points and to the body of the wafer complete the transistor.



Duro-Test Corp.

New Xenon bulb developed by Duro-Test Corporation, in cooperation with U.S. Army Engineer Research and Development laboratories.

XENON GAS EMPLOYED IN EXTREMELY BRIGHT ARC LAMP

A major break-through in the field of xenon high brightness, long-range illumination has been achieved by the Duro-Test Corporation in cooperation with the United States Army Engineer Research and Development Laboratories. Xenon high pressure, high brightness bulbs are a new type of powerful lamp for military use searchlights, projectors and space applications. The rays of the xenon lamp can be projected for a distance of fifty miles.

In one "envelope," the bulb has three brilliant arc discharges spaced approximately one-quarter of an inch from the other, differing in this way from one-arc conventional lamps. The availability of the three closely spaced arcs, which can be switched and regulated independently, makes the lamp particularly useful for military, space and commercial applications. Xenon bulbs have distinct advantages over conventional lamps because of their maintenance free operation and perfect daylight color.

The extreme brilliance of xenon bulbs is due to the high concentration of this rare gas found in the lamps. The shells of xenon bulbs must be made of fused quartz, the only suitable transparent material with a softening point as high as 3500°F. These highly heat-resistant bulbs are filled with more than ten times atmospheric pressure of xenon (more than 140 pounds per square inch). Xenon lamps are considered to be the most advanced and intricate products of the electric lamp industry to date.

ARMY DEVELOPS NEW MOBILE ACETYLENE PLANT

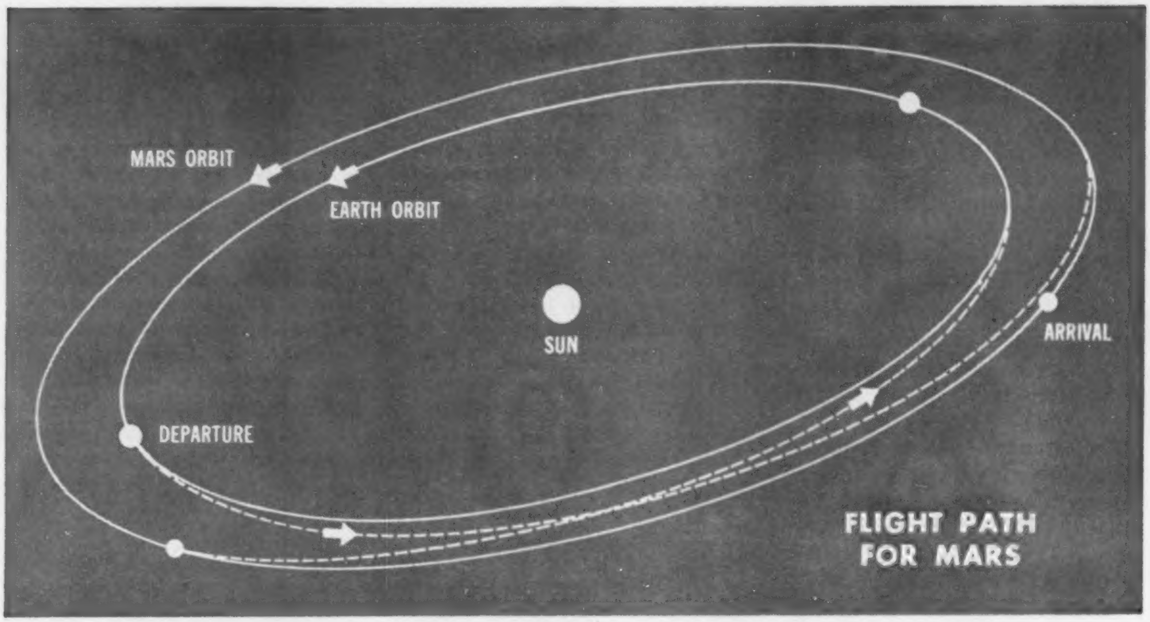
Development of a mobile acetylene plant utilizing a hydrocarbon fuel rather than calcium carbide has been announced by the U. S. Army Engineer Research and Development Laboratories.

The new plant is expected to have several advantages over the existing carbide plants used in the field production of acetylene for cutting and welding. These include multi-fuel capability, and readily available, relatively non-hazardous raw materials.

The new plant utilizes JP-4 jet fuel as raw material. The process involves the thermal cracking of the jet fuel at high temperature to produce a raw gas stream containing approximately 15 percent acetylene. This raw gas stream is subsequently purified to produce a 95 percent acetylene product which is compressed and loaded into cylinders. It has a design production capacity of 500 standard cubic feet per hour of acetylene.

During World War II, logistic problems involved in shipping acetylene over long distances in cylinders spurred the development of mobile field acetylene generating plants capable of producing up to 750 standard cubic feet per hour of gas. These plants, now military standard, use the carbide process in which calcium carbide reacts with water to form acetylene directly. However, because calcium carbide is potentially hazardous to transport and store, and is also a single purpose military supply item, there was a requirement for a plant that would use a raw material other than calcium carbide.

The basic research on the thermal cracking process using a hydrocarbon fuel, rather than calcium carbide, and the construction of the experimental plant was performed under contract negotiated by the Laboratories with the Institute of Gas Technology, Chicago, Illinois.



new areas of interest enhance careers for engineers and scientists at Hamilton Standard

HAMILTON STANDARD DIVISION of United Aircraft Corporation has long been a dynamic force in the aircraft equipment field . . . with an unmatched record of stability and accomplishment. Typical of Hamilton Standard's achievements are environmental conditioning systems which are standard equipment on such aircraft as the 1400 mph Convair B-58 Hustler Bomber. Fast moving advances in space technology, however, pose new problems . . . new challenges.

TO MEET THESE CHALLENGES Hamilton Standard is conducting advanced research and development on environmental control problems for manned space vehicles. The Moon Room pictured at right was specifically designed to assist engineers and scientists in identifying and analyzing the practical problems involved in CO_2 regeneration. However, within such sealed experimental chambers studies can be conducted to develop means of removing or regenerating body heat, water vapor, nitrogen and other contaminants given off by man in a space vehicle. Several possibilities exist for effecting each phase of control in an environmental control system. For example, CO_2 can be removed by the freeze-out method, chemical absorption, physical adsorption and diffusion or filtration of molecules. Consideration of the space envelope and the weight of equipment must be made. In the case of CO_2 this involves heat exchangers, regenerators, water separators, blowers, valves and vents. Need for secondary electrical power supplies to operate equipment creates additional problems.

OBVIOUSLY, UNDERTAKINGS of this nature involve the utilization of a wide variety of engineering and scientific fields of study providing intellectual growth and career satisfaction.

MOON ROOM—Leo Farwell, BSME Wisconsin '53, right, enters the Moon Room with analyzer as Sid Russell, BS Chem. Rutgers '52, checks CO_2 control. These young men, who are in the Advanced Product Planning Group, have played a major role in actually designing and developing the equipment and test programs for this undertaking.

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UNITED AIRCRAFT CORPORATION

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COLLEGE NEWS

Edited by John Hughes, EP '64

CORNELL RECEIVES GRADUATE FELLOWSHIPS FROM KODAK

Two fellowships, one for Ph.D. degree study in physics and the other for M.S. degree study in engineering, and a direct grant of $22,800 have been awarded Cornell University by the Eastman Kodak Company.

Since 1945, Cornell has received a total of 20 fellowships from Kodak. In the past six years, it has received more than $76,000 in direct grants from the company. The fellowships and grants are part of Kodak's aid-to-education program, which this year amounts to more than $800,000, moderately above the corresponding total a year ago. Students to receive the fellowships will be chosen by the University, with selection based upon financial need and ability.

The recipient of the Ph.D. award for 1961–62 will receive $2,500, or $3,000 if married and with dependent children. Also provided are tuition and fees, funds to enable the student to attend one professional meeting in the field of physics, and an additional $1,000 to the university to help defray research expenses. The engineering fellowship provides $1,500 for the student, while the university will receive the actual cost of tuition and fees.

Direct grants are given by Kodak to privately supported colleges and universities on the basis of the number of graduates of each institution who joined Kodak five years ago and are presently employed by the company. This year's grant to Cornell University is based on Richard L. Freeman and Hugh H. Whitney, Class of 1951; David P. Beardsley, Thomas S. Foulkes, Robert T. Lewis, and William R. Welsh, Class of 1953; and David L. Champlin and Milton Cherkasky, Class of 1955.

Kodak's grants are designed to help schools compensate for the difference between the actual cost of educating graduates now with Kodak, and the amount that these graduates may have paid in tuition and fees. The direct grants also serve to recognize the role that graduates of these institutions are playing in the company's progress.

—Bob Solomon EE '64

CORNELL PROFESSOR TO STUDY TRANSPORTATION PROBLEMS

The head of the Department of Transportation Engineering at Cornell University, Professor Taylor D. Lewis, has received a Senior Visiting Fellowship from the National Science Foundation for a six month study of transportation problems at the Road Research Laboratory in England.

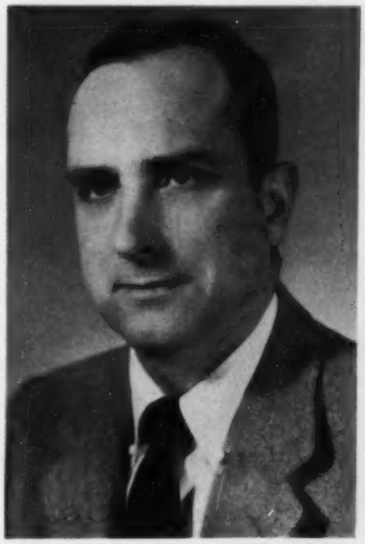

Photo Science

Prof. Taylor D. Lewis

Professor Lewis will review and appraise the research techniques that are being developed to help solve the complex problems that affect various methods of transportation. He will be in England until February 1961.

The Road Research Laboratory, near London in Harmondsworth, Middlesex, is part of England's Department of Scientific and Industrial Research. It is utilized by many English transportation organizations including the British Railways, the British Overseas Airways Corporation, and the British Transport Commission.

Professor Lewis, a member of the Cornell faculty since 1946, is a native of Detroit, Michigan. He received the bachelor of science and civil engineering degrees from the University of Michigan. He received a certificate from Harvard University's Bureau for Street Traffic Research and has also done graduate work at Cornell. A lieutenant colonel in the Army during World War II, he served as an operations analyst during the Korean War.

Since 1949 he has acted as traffic consultant to four municipalities and has appeared in more than 30 law cases as an expert witness. He is a fellow of the American Society of Civil Engineers, a member of the Institute of Traffic Engineers, a member of the American Road Builders Association, an associate member of the Highway Research Board, and the American Society of Testing Materials. He has written more than 70 articles for leading engineering journals.

DESIGNERS OF NEW MATERIALS SCIENCE CENTER SELECTED

A distinguished alumnus and a former member of the Cornell University College of Architecture faculty have been named as the principals who will design the University's new Laboratory of Atomic and Solid State Physics Building, which will house a large part of the Materials Science Center.

They are Jacob Fruchtbaum of the engineering firm of J. Fruchtbaum, Buffalo, N.Y., a 1917 graduate of Cornell, and Charles H. Warner Jr., of the architectural firm of Warner, Burns, Toan and Lunde, 414 Madison Avenue, New York City.

The Advanced Research Projects Agency of the U.S. Department of Defense will contribute approximately $4,000,000 in support of the Laboratory. The University will contribute the site and will finance construction.

Mr. Fruchtbaum has been commissioned by Cornell as engineering consultant to supply mechani-

cal and structural design drawings and specifications of the planned building and its interior.

His organization has been instrumental in the design of the Massachusetts Institute of Technology nuclear reactor building, the University of Western New York Nuclear Research Center, Buffalo, several research laboratories of Union Carbide Corp., Sylvania's Electronics Laboratory in Amherst, N.Y., the Lucidol Chemical Laboratory, Tonawanda, N.Y., and the multi-million dollar laboratory of Union Carbide in Marietta, Ohio.

Mr. Warner will be special architectural consultant to the University regarding the building exterior and will advise on site planning. Creation of the site design and the exterior of the building will take into consideration surrounding campus terrain and buildings. The firm of Warner, Burns, Toan and Lunde designed the nearly completed $5,700,000 John M. Olin Library for research at Cornell.

The firm was consulted on the architectural design of the Caribe Hilton and La Concha Hotels, and the Supreme Court Building of the Commonwealth of Puerto Rico, and Hilton hotels in Athens, Greece, and Trinidad. In addition it has participated in the design of buildings on several university campuses and a church in Princeton, N.J.

The engineering and architectural consultants will coordinate their creative efforts with University committees headed by Franklin A. Long, professor of chemistry, and Prof. Robert L. Sproull, the director of the new Cornell Materials Science Center.

The new Laboratory of Solid State Physics will be constructed near the physics and chemistry buildings so that activities of the two fields in connection with materials science research can be carried on more effectively.

Materials Science, the area of research which will be undertaken, is the investigation of physical and chemical processes in solids such as metals, ceramics, semiconductors and plastics. The need for the design of new substances for nuclear reactors, rocket engines, transistors, and other atomic and space age devices stems from an inadequacy of known materials when subjected to nuclear-space conditions.

There is a need for materials capable of performing under extreme tensions, heat and speeds now encountered in defense explorations. For example, our country does not have a nuclear-powered bomber because no material has been found that is strong enough and light enough to encase a nuclear reactor; space probes are limited in distance because there are vital missing links in materials capable of withstanding the vacuum of outer space.

Professor Sproull, 41-year-old solid state physicist, has been appointed to head the program at Cornell. He is responsible for the day-to-day administration of all research projects in materials science, as well as for research and graduate student training in the field. The Center will include the efforts of portions of five existing departments in two colleges at Cornell.

Some ideas just won't wait

With over 70 advanced projects in the works, the Northrop atmosphere is so stimulating that ideas often refuse to wait — they compel attention wherever the inspiration strikes. Missile guidance, rendezvous and maneuverability in space, bioastronautics, universal checkout systems, laminar flow control for aircraft present insistent, gratifying challenges. If you have sharp creative abilities in these lines, investigate the intellectually invigorating environment and rewards offered by Northrop's current and future programs.

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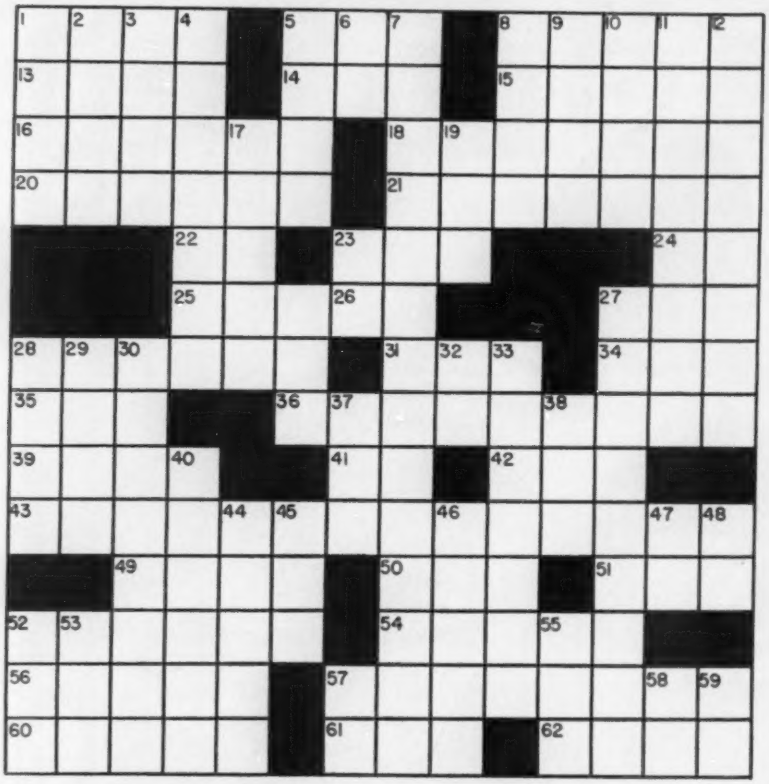
BRAIN STRAINER



By Gerald Rappe, ChemE '62

DEFINITIONS
ACROSS

1 Harmonize
5 Unit of current
8 Famous mathematician
13 Body of water off Africa
14 Long period of time
15 Urge on
16 Seesaw
18 Puzzles
20 Fish hawk
21 Cause to forget
22 Coordinating particle
23 American coin; d________
24 Movie company (abbr)
25 Musical instrument
27 Baby food
28 Without a __________
31 Animal bleat
34 Suffix
35 Commie
36 Football pals
39. ______word and ______word
41 Used in power transmission
42 New York State School
43 Process of bonding molecules
49 A king (comb. form)
50 Toss
51 Earth from which iron is obtained
52 Reason
54 ______and behold, the candle is ____.
56 Crest of a mountain range
57 Resident of early eastern Europe
60 Beat out by a hair
61 Donkey
62 Reflected sound

DOWN

1 Jet assisted takeoff
2 The fifteenth of April
3 Sound of a small automobile
4 Measure of unavailable energy
5 Aerial
6 Symbol for degrees
7 Bacteria causing lung diseases
8 Proofread
9 Push
10 Capital of Peru
11 Empty of air
12 Make anew
17 Eagle's nest
19 Last three letters of a type of soup
23 Prefix meaning not
26 Sculpture, painting, etc.
27 One who loves one's country
28 Release
29 City in Nevada
30 Flatters
32 "I think, therefore, I ______!"
33 Friendly
37 Corn cob
38 Altitude (abbr)
40 Fool's gold
44 Pushed around
45 Organ of vision
46 Soars
47 One ______ the other
48 Compass direction
52 A thinking
53 Spanish word for gold
55 Anger
57 South America (abbr)
58 Sound of pleasure
59 Absolutely not

← (Answers to October Puzzle)

One of a series

Interview with General Electric's Byron A. Case Manager—Employee Compensation Service

Your Salary at General Electric

Several surveys indicate that salary is not the primary contributor to job satisfaction. Nevertheless, salary considerations will certainly play a big part in your evaluation of career opportunities. Perhaps an insight into the salary policies of a large employer of engineers like General Electric will help you focus your personal salary objectives.

Salary—a most individual and personal aspect of your job—is difficult to discuss in general terms. While recognizing this, Mr. Case has tried answering as directly as possible some of your questions concerning salary:

Q Mr. Case, what starting salary does your company pay graduate engineers?

A Well, you know as well as I that graduates' starting salaries are greatly influenced by the current demand for engineering talent. This demand establishes a range of "going rates" for engineering graduates which is no doubt widely known on your campus. Because General Electric seeks outstanding men, G-E starting salaries for these candidates lie in the upper part of the range of "going rates." And within General Electric's range of starting salaries, each candidate's ability and potential are carefully evaluated to determine his individual starting salary.

Q How do you go about evaluating my ability and potential value to your company?

A We evaluate each individual in the light of information available to us: type of degree; demonstrated scholarship; extra-curricular contributions; work experience; and personal qualities as appraised by interviewers and faculty members. These considerations determine where within G.E.'s current salary range the engineer's starting salary will be established.

Q When could I expect my first salary increase from General Electric and how much would it be?

A Whether a man is recruited for a specific job or for one of the principal training programs for engineers—the Engineering and Science Program, the Manufacturing Training Program, or the Technical Marketing Program—his individual performance and salary are reviewed at least once a year.

For engineers one year out of college, our recent experience indicates a first-year salary increase between 6 and 15 percent. This percentage spread reflects the individual's job performance and his demonstrated capacity to do more difficult work. So you see, salary adjustments reflect individual performance even at the earliest stages of professional development. And this emphasis on performance increases as experience and general competence increase.

Q How much can I expect to be making after five years with General Electric?

A As I just mentioned, ability has a sharply increasing influence on your salary, so you have a great deal of personal control over the answer to your question.

It may be helpful to look at the current salaries of all General Electric technical-college graduates who received their bachelor's degrees in 1954 (and now have five years' experience). Their current median salary, reflecting both merit and economic changes, is about 70 percent above the 1954 median starting rate. Current salaries for outstanding engineers from this class are more than double the 1954 median starting rates and, in some cases, are three or four times as great.

Q What kinds of benefit programs does your company offer, Mr. Case?

A Since I must be brief, I shall merely outline the many General Electric employee benefit programs. These include a liberal pension plan, insurance plans, an emergency aid plan, employee discounts, and educational assistance programs.

The General Electric Insurance Plan has been widely hailed as a "pace setter" in American industry. In addition to helping employees and their families meet ordinary medical expenses, the Plan also affords protection against the expenses of "catastrophic" accidents and illnesses which can wipe out personal savings and put a family deeply in debt. Additional coverages include life insurance, accidental death insurance, and maternity benefits.

Our newest plan is the Savings and Security Program which permits employees to invest up to six percent of their earnings in U.S. Savings Bonds or in combinations of Bonds and General Electric stock. These savings are supplemented by a Company Proportionate Payment equal to *50 percent* of the employee's investment, subject to a prescribed holding period.

If you would like a reprint of an informative article entitled, "How to Evaluate Job Offers" by Dr. L. E. Saline, write to Section 959-14, General Electric Co., Schenectady 5, New York.

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